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Journal of the Northern California QRP Club

From the Editor

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Wow, Dayton is fast approaching and we are finishing our fourth year as a club with our 4th anniversary on the first Sunday in June. It seems like only yesterday that Jim and I wanted to see if we could get 15 or 20 guys interested in forming a local QRP group.

Now there are over 2000 members of NorCal in all 50 states, and 75 foreign countries. Our latest kit, the 38 Special has broken all of the records for kits by NorCal. We distributed over 1000 kits in 2 months. That means that Jim handled 1000 orders, and that Doug had to sort and package 100,000 parts! That is a lot of work, but it also means that now there are tons of 30 meter rigs being built and on the air.

Anytime that you do things, there will be mistakes and we make them just like anyone else. There were some bad VXO crystals in the second batch of kits. If you have a crystal that is marked KOYO, 22.1184, 87-35, please let us know as you have a bad crystal. We will replace it for no charge. Just contact us by email (best way), phone, or snail mail, and be sure to include your address and how many kits have the bad crystal. I will take the responsibility for the mistake as I did not test the crystals when I received them. The problem is that they are third overtone crystals and will not tune in the circuit. Please do not return the crystal, as we have no use for it.

Also, if you have any missing parts in your kits, please let us know, and we will send them to you. But, we do ask that you be patient, and sometimes it will be much easier and faster if you can get the parts locally. But, there are some parts in the kit that are not available at the local Radio Shack, so let us know if you need them.

With all of the 38 Specials out there, NorCal has decided to offer 2 plaques to the first person to work DXCC with a 38 Special, and to the first person to work WAS with a 38 Special. You do not have to have QSL cards to qualify, just send a copy of your log verifying the contacts were made on a 38 Special, and have it signed by two other amateurs. The first entry to reach me will be the winner. Only one plaque will be awarded in each category.

Inside this issue you will see the SST construction article by Wayne Burdick, N6KR. The SST is NOT a NorCal kit, because of time restraints. Wayne offered the kit to us, but we just don't have time to kit it at this time with our other obligations that we have. We are working on a 40 meter version based on the 38 Special, and the earliest that we could have gotten to the SST would have been in the fall. Jim and I met and decided that it would be in the members best interest to have Wilderness take the SST and make it a commercial product from the beginning. That way, we won't have to wait 6 more months for the SST to be available.

Wilderness is offering a special price to the readers of QRPp that will save you about $16 if you act before May 1st. That was their decision, and we have nothing to do with it. If other QRP companies want to extend a special offer with a new kit, they are welcome to do so. But, we do ask that a construction article complete with schematic, parts list, and alignment instructions be a part of the package. The SST can be built from scratch with the article in this issue. 72, Doug, KI6DS

Subscription Rate to QRPp Takes an Increase

by Doug Hendricks, KI6DS
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and
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QRPp subscriptions have gone up to $15 effective Feb. 1, 1997 for US subscribers. This decision was not made lightly, but was done after long hours of soul searching between Jim and I. We have a serious problem here in the US with delivery of bulk mail by the US Post Office. The winter or December issue of QRPp was mailed the last week of December to avoid the Christmas mail rush that was encountered last year. Was that ever a mistake.

Delivery was horrible, with many members not receiving their issues until March!! Jim and I both received hundreds of messages about "Where is my QRPp? Am I on the list, etc. etc." This was understandable, but it took a tremendous amount of time for Jim and I to read each message, check the data base, and then compose an answer.

Many were upset that their issue was delayed, but Jim nor I could do nothing about it. We published it, we sent it to the printer, and he mailed it. I have proof, as I have a copy of the Post Office receipt when he delivered the copies to the Post Office.

Therefore, we are going to start mailing QRPp First Class Mail to all subscribers in the US. That means that we have to have more money for subscriptions, as the cost is significantly higher. Also, the printer has informed us that our printing costs are going up also.

The problem is that we have a lot of unsent issues that were subscribed to at the bulk mail rate. Again, Jim and I discussed this, and we will honor our committment to send out issues for the old rate. But, we would like your help.

If you will look at your mailing label on this issue, you will see an expiration date. If you did not subscribe at the $15 per year rate, Jim and I are asking that you send us $1 for each remaining issue in your subscription. Use the table below to figure out your rate. If the expiration date is:

June 1997	= $1
Sept. 1997	= $2
Dec. 1997	= $3
Mar. 1998	= $4
June 1998	= $5
Sept. 1998	= $6
Dec. 1998	= $7
Mar. 1999	= $8

Please send to Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. This applies to US subscribers only.

We will not keep track of who sends in extra money, that is not our purpose. Jim and I will make up the shortfall if necessary, but we do appreciate your help.

Also, starting with this issue, we will have a Spring, Summer, Fall and Winter issue of QRPp. I will try and get it out in March, June, September and December, but there may be times that I am a little late. This is a hobby, and QRPp is a club publication, NOT a commerical magazine. I am the only staff member of QRPp, and Jim is the only one doing the paper work. Please have patience with us.

We regret the subscription increase, but feel that it will be worth it to have timely delivery of QRPp. 72, Jim and Doug

Return of the Gimmick Capacitor

by Floyd E. Carter K6BSU
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A staple of home brew design is the ability to design and build L-C filters. Normally, we can design simple low-pass and high-pass L-C filters and then go out and find parts values which are not exact, but close. Often we settle for the next standard capacitor value, and this is usually close enough. However, component values are critical in multi-pole band-pass filters for the HF and higher bands, which often contain capacitors under 10 pFd. Design equations for 2-pole-pair and 3-pole-pair L-C bandpass filters are given in many text books, including "Solid State Design for the Radio Amateur", an ARRL publication.

In the days of vacuum tubes and very high impedances, the "gimmick" capacitor was commonplace. It consisted of two pieces of hookup wire twisted together so that the two wires represented the "plates" of a capacitor, and the wire insulation served as the capacitor dielectric material. The actual capacitance value depended on the thickness of insulation, its dielectric constant, the number of twists per inch, and the length of the twisted pair. The "gimmick" is an accurate and reliable means of fabricating small-value capacitors, especially when they are fabricated with readily-available "Kynar" 30 ga. wire-wrap wire. If the 'gimmick" material is prepared according to the following instructions, it is only necessary to measure and cut off the length of twisted pair needed.

Cut two lengths of Kynar 30 ga. wire-wrap wire about 4' long. Clamp one end of each wire in a vise and chuck the other ends in a portable drill motor. Make sure the wires are exactly equal in length by gently pulling the wires. The two wires should have equal tension. Now with moderate tension on the wires, run the drill until the wires are twisted at exactly 10 full twists per inch. The twists will spring back a bit when removed from the drill motor, so it works best to slightly over-twist the pairs and then operate the drill motor in reverse until you measure 10 twists per inch.

The measured capacitance of this twisted pair is 1.5 pF per inch. Since this is linear, no table is required, just divide the desired capacitance value by 1.5 and the answer is in inches. As an example for a 5.25 pF capacitor, the length of twisted pair is 3.5 inches. Do not count the part of the wire which is un-twisted to solder on to your circuit board. After the gimmick has been soldered in to the circuit, the wire may be folded down to take up less space. 72 de K6BSU

Comparing Filters in the NorCal 40A & Sierra Transceivers

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The NorCal40A and Sierra transceivers are popular kits. It is interesting to compare the two because the NorCal40A has a fixed-bandwidth IF filter and the Sierra has an adjustable-bandwidth IF filter. I have made plots of the combined IF-filter/Audio-amplifier response and measured the bandwidth, shape factor, USB (upper sideband) rejection, and MDS (Minimum Detectable Signal, or the signal power that gives a 1:1 S/N ratio at the output).

Measurements

I adjusted the BFO (beat-frequency oscillator) on each transceiver to give a peak audio output at 650 Hz. The audio frequency was determined by tuning halfway between E and E flat on an electronic tuner (Matrix SR-4000). Both transceivers were set to receive at a center frequency of 7.025 MHz. I used a signal generator (HP 8656B) to vary the frequency from 2 kHz below the center frequency to 2 kHz above. I began with an input power of -125 dBm at the center frequency. This power was low enough that it did not cause the AGC to reduce gain. At other frequencies, I increased the power to maintain a constant audio rms voltage as measured on a Fluke 87 true-rms multimeter. To see the filter response I plotted the change in RF power. From the response curves I measured the 6-dB bandwidth, shape factor (the ratio of the 40-dB bandwidth to the 6-dB bandwidth), and the USB rejection ratio. It is more common to plot a shape factor with a 60-dB bandwidth but I used the 40-dB bandwidth because sometimes the response did not drop 60 dB. The MDS was found by comparing the audio signal with the audio noise when the signal generator was off.

These measurements could be made in a different way if an oscilloscope and a step attenuator are available instead of a signal generator. First the transmitter power for each radio is reduced to -20 dBm, measured on the oscilloscope. Then the radios are connected to each other through the step attenuator, which is used to vary the signal power. In this approach, each transceiver serves as the signal generator for the other.

In these measurements, the response depends on both the IF filter and the frequency response of the audio amplifier, without separating the two. However, the measurements should give information about the overall performance of the radios.

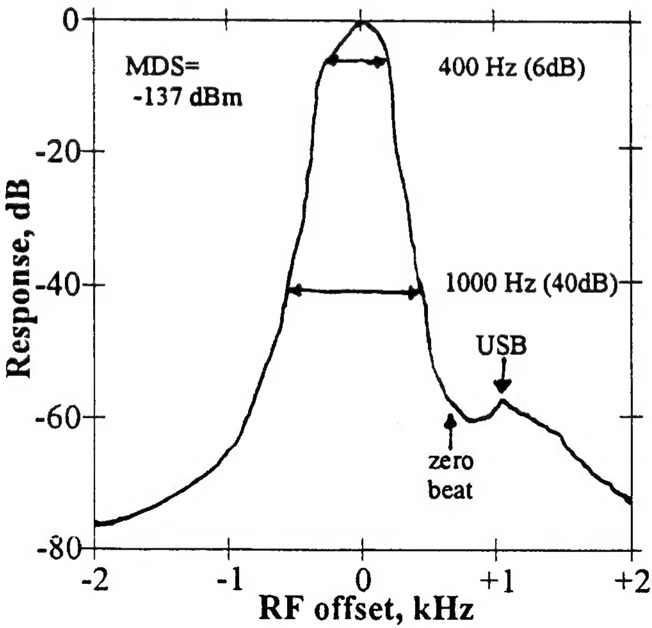

Figure 1. IF/Audio response of the NorCal40A.

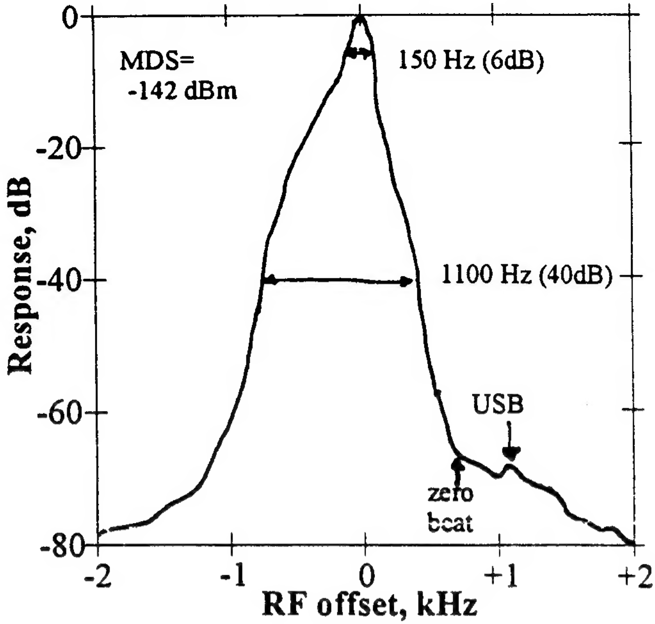

Figure 2. Response of Sierra with narrow IF filter setting.

Results

Figure 1 shows the response for the NorCal 40A as a function of the frequency offset from 7.025 MHz. The 6-dB bandwidth is 400 Hz. There is a slight shoulder visible 8 dB down. The 40-dB bandwidth is 1000 Hz, giving a shape factor of 2.5. The USB rejection ratio, is 57 dB. The MDS is -137 dBm.

For the Sierra, I plotted the response for narrow, medium and wide settings of the adjustable IF filter. I used Construction Option 1 that sets the BFO below the center frequency of the crystal filter. I found that this option greatly improves the USB rejection. Figure 2 shows the filter response at the narrow setting (ABX control centered at 12 o'clock). The 6-dB bandwidth is 150 Hz and there is a pronounced shoulder 20 dB down. The 40-dB bandwidth is 1100 Hz giving a fair shape factor of 7.3. The USB rejection is an excellent 68 dB, and the MDS is -142 dBm.

For medium filter bandwidth, I set the ABX control slightly to the left of center (11 o'clock). The 6-B bandwidth is 250 Hz and the 40-dB bandwidth is 1400 Hz, giving a shape factor of 5.6. There is a shoulder 35 dB down. The USB rejection is 58 dB, and the MDS is -140 dBm.

Finally, I set the filter to a wide bandwidth (ABX control at 10 o'clock). The 6-dB bandwidth is 750 Hz and the 40-dB bandwidth is 2350 Hz, giving a shape factor of 3.1. There is a pronounced shoulder at the 18-dB level. The USB rejection is only 40 dB. The MDS is -136 dBm.

Discussion

The Sierra gives a wide choice of bandwidths, but the NorCal40A's 2.5-shape factor is better. Comparing the USB rejection ratios is more complicated. The narrow Sierra filter gives better USB rejection than the NorCal40 A's 57 dB but the wide Sierra filter's USB rejection is much worse. The medium Sierra filter

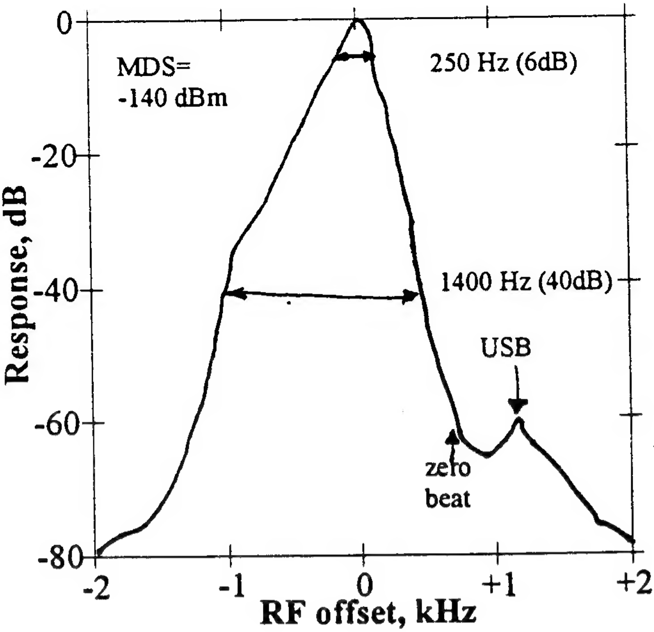

Figure 3. Sierra response with medium filter setting.

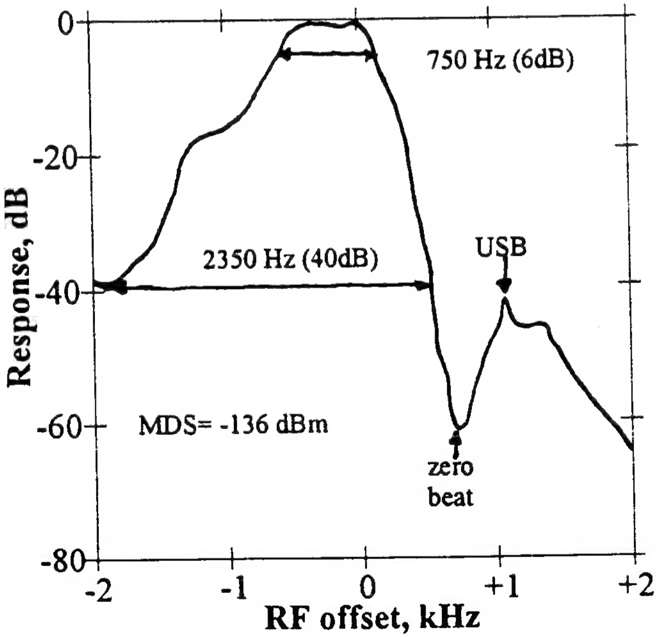

Figure 4. Sierra response with wide IF filter setting.

has similar USB rejection.

All measurements showed good MDS values that are considerably lower than typical 40-meter atmospheric-noise power levels, -90 to -120 dBm. This means that both radios are almost always limited by atmospheric noise, rather than set noise. The shoulders in these response curves are much more pronounced in the Sierra than in the NorCal40A. Maybe readers could comment on the effect of these shoulders on the practical performance of the radios.

Acknowledgments

I made these measurements while helping develop exercises in electronics as a summer volunteer at Caltech.

The Rambo Audio Board = More Audio for the HW-8

by Floyd Carter, K6BSU
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For some unknown or long forgotten reason, the Heath Co. designed the HW-8 transceiver with an audio output impedance of 1000 ohms. Perhaps they thought everyone had high Z earphones, but 8 ohm phones and speakers are more common. As a result, audio volume is marginal with phones, and almost useless with a loudspeaker.

This easy modification replaces the original HW-8 version. the new circuit features the popular LM386 integrated circuit audio power amplifier. The amplifier has two inputs. The "IN" terminal is the low level audio input from the front panel audio gain control. The "BB" terminal is the transmit sidetone signal from the pad "BB" on the main circuit board. The original sidetone monitor signal went directly to the phone jack in parallel with the audio amplifier output. This old configuration is not compatible with the much lower output impedance of the new audio board. Summing the sidetone with receive audio at the input of the LM386 audio amplifier permits independent control of sidetone volume and receive audio.

A suitable circuit board pattern is shown full size with the foil side up. All of the components are available from Radio Shack, makin this project accessible to everyone. Further a PC board is available from K6BSU. Write for details but please be sure to enclose a self addressed stamped envelope for a reply.

Out With the Old

After the new audio board is finished, let's get rid of the old audio board in the HW-8. Here's a step by step procedure.

☐ 1. Remove wire "+13" (audio board) to "VA" (main board.

☐ 2. Remove wire "GND" (audio board) to J101 (phone jack ground).

☐ 3. Remove wire "OUT" (audio board) to J101 (phone jack tip lug).

☐ 4. Remove wire "IN" (audio board). This is the green wire from the cable going to the audio gain control.

☐ 5. Remove wire "BB" (main board) to J101 (phone jack tip lug).

In with the New

Install the new audio board using the single screw through the center of the audio board. Install the following 22 gauge stranded wires:

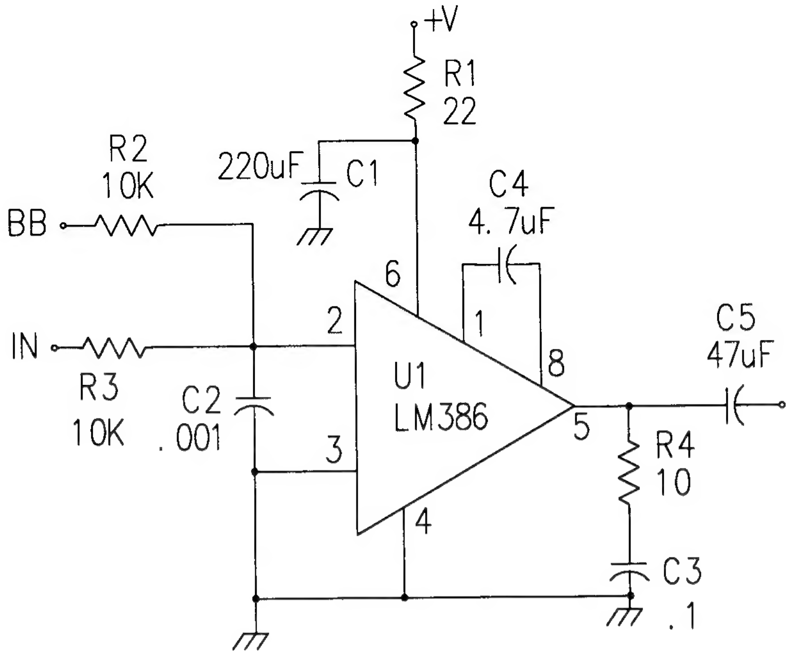
☐ 1. Install wire "+13" to "VA" (main board).

☐ 2. Install wire "GND" (audio board) to J101 (phone jack ground).

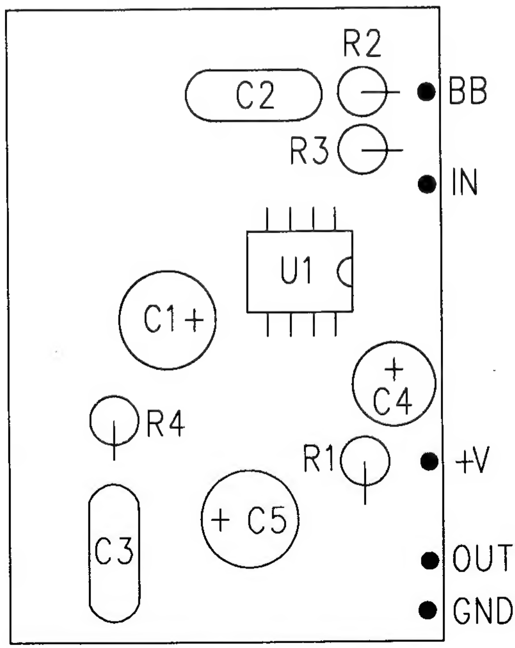
☐ 3. Install wire "OUT" (audio board) to J101 (phone jack tip lug).

☐ 4. Install wire "IN" (audio board). Use the existing green wire from the audio gain control.

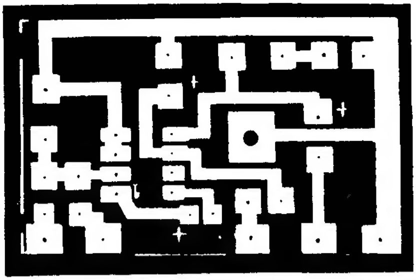
☐ 5. Install wire "BB" (main board) to pad "BB" on the main board.



K6BSU "Rambo Audio Board for the HW-8"



Parts Layout for the K6BSU "Rambo Audio Board"



PC Board "Negative" Foil Side Up

The astute reader will notice that the preceding steps removed wires and then installed other wires to the same points on the HW-* main board and chassis. If your HW-8 was built using the solid hook-up wire from the kit, you will thank me for telling you to throw away the solid hook-up wire and replace it with flexible stranded wire.

Adjustment

There is probably little advantage in a separate test of the new audio board. Success is almost guaranteed, providing the polarized capacitors and the IC are oriented correctly. The sidetone level potentiometer on the main board will require adjustment. Set this for the amount of transmit sidetone desired in your loudspeaker.

This circuit may be used for purposes other than the HW-8. It is a universal audio power amplifier with the following specifications:

Input Z = 10K ohms
Max power out (12V) = 550mW into 8 ohms.
Input for full output = 30 mV RMS
Power Gain = 68 dB

RF Fun with the RF-1 or How I Learned to Love Complex Numbers

by Dan Maguire, AC6LA
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I recently finished designing and building my very first vertical phased array antenna system. This was the first antenna I've ever built where the mathematics were any more complex than L = 234 / F. Along the way I had a ball learning all the new things I needed to know about, and had several of those very pleasant "Aha" moments where things just seem to fall into place all of a sudden. I thought I'd share some of my experiences.

When playing with phased arrays, one of the first things you learn is that it would be nice to be able to measure complex impedance values, of the form R + jX, where R is the resistance value (almost always a positive number) and X is the reactance value, positive for inductive reactance and negative for capacitive. In fact, it's nice to be able to measure complex impedance even if you don't work with arrays.

Well, I don't own a Hewlitt Packard Vector Impedance Meter, I don't own a Network Analyzer, and I don't own a General Radio laboratory grade Impedance Bridge. Heck, I don't even own a run of the mill noise bridge. But I do own an Autek RF-1 RF Analyst.

"Big deal," you say. "The RF-1 is great for measuring SWR right at the antenna, without having to climb down off

the roof and run back to the shack every time you trim off a few inches of wire. It also can measure total impedance (the combination of resistance and reactance, usually denoted by the letter Z), along with inductance in microhenries and capacitance in picofarads. It can even be used as a digital readout signal source for calibrating the analog dial of my latest QRP rig. But one thing it can't do is give you the components of Z, namely R and X."

"But wait!," I say, glad to get a word in edgewise and wondering if you are a sales rep from the Autek factory. "You can use the RF-1 to find R and X. Let me show you."

In "The ARRL Antenna Compendium Volume 4", on page 175, there is an excellent article by Peter Dodd, G3LDO, on measuring impedance using a technique called the Three Meter Method. Actually, Dodd is giving some new enhancements on a method first published by D. Strandlund, W8CGD, back in the June 1965 QST. And although I doubt very seriously that I'm the first ham to think of it, what I'll describe here is a slightly different twist on the Dodd method.

I won't attempt to duplicate the complete article here. If you're interested you'll probably want to buy the book (and bundled diskette) anyway. But let me just give an abbreviated description of the technique.

The total impedance, Z, is calculated by taking the square root of the sum of the squares of the R and X components. As an example, an impedance of R+jX = 40+j10 could be expressed as Z = 41.23. Suppose we used the RF-1 to measure this impedance. Assuming for a moment that the precision could be displayed to the hundredth of an ohm, it would read 41.23. But since there are lots of resistance and reactance combinations that also equal a total impedance of 41.23 (like 20+j36.06, or 41.23+j0, or 0+j41.23), all the RF-1 can tell you so far is that the impedance you are measuring lies somewhere on a circle with a radius of 41.23. See Figure 1. In order to keep the plot from getting overly complicated, I've shown just a portion of the circle in the form of an arc.

Next we take a similar measurement, but this time we put a fixed value of capacitive reactance in series with the unknown. For example, suppose we connect a capacitor with a reactance of 60 ohms at the frequency of interest in series with our unknown. Then we take a measurement and plot the same kind of circle (arc) on the same piece of graph paper as our original arc, but this time using a new origin point. We move up 60 units and call that our new origin. (Even though capacitive reactance is negative, we moved "up" so that our first origin point would then be exactly 0-j60 away from our new origin.) In our example, the impedance of 40+j10 connected in series with a capacitor which has an impedance of 0-j60 would now become 40-j50. The total impedance would then be Z = 64.03, which is what the RF-1 would show, and that's what's used as the radius of the new arc.

Last step. Now connect a resistor of known value in series with the capacitor and take a final measurement. Suppose for example it's a 50 ohm resistor, which expressed as an impedance is 50+j0 ohms. When placed in series with 40+j10 and 0-j60, the combination would be 90-j50, or Z = 102.96. That's the value the RF-1 would show, and that's the radius of the final arc we draw, this time from an origin that's 50 units left of the previous one. See Figure 2.

Well what do you know! The intersection of the three arcs just happens to be at point 40+j10 when measured from origin #1, even though we never got any readings other than total impedance from the RF-1. Now if you've followed along

so far, you see that we theoretically did not need to draw arcs from both origins #2 and #3. Either one would have intersected with the arc from origin #1 to give us our answer. However, the RF-1 only gives a precision to 1 ohm, not 0.01 ohms. Also, taking readings from three different points lets us verify the accuracy of the other two. (Navigators do this also. To find their position, they take a bearing on three landmarks on shore, or three radio beacons, or three stars, or whatever. They then draw the three bearing lines on a chart. Because of slight errors in the readings, the intersection is usually not precise but instead looks like a skewed triangle. Old time sailors called this a "cocked hat.")

Now you've got the basics of how to determine a complex impedance value of the form R+jX when all you can measure is total impedance, Z. (Again, W8CGD gets full credit for inventing this novel approach.) All you need is a piece of graph paper, the RF-1 (or some other means of measuring total impedance), a drawing compass to draw the arcs, and some means of connecting a fixed capacitor and resistor in series with the unknown.

In my setup, I soldered a capacitor to the center pin of an SO-239, then soldered a resistor to the other side of the capacitor. The other lead from the resistor just hangs in space. Then I used the alligator clips that came with the RF-1 (The Autek people seem to think of everything!) to take measurements of the known R and the known C (both of which might not conform exactly to their respective markings) and the unknown impedance from the SO-239 shell to point 1, 2, and 3 as indicated on Figure 3.

To eliminate as much stray reactance as possible keep all leads very short. I soldered about a half inch of bare hookup wire to each clip. I attached the ground clip by laying its wire against the shell of the SO-239 on the RF-1 and holding it with a rubber band. I took the short wire from the other clip, stuck it right in the center hole of the RF-1 SO-239, and held it in place with a small piece of center conductor insulator from a scrap of RG-8X. (Thanks go to N2CX for that trick, via the ARCI QRP Quarterly.)

Of course, this is the age of computers. Wouldn't it be great if we could just take some readings with our test instrument, plug the numbers into a program, and let the program do all the business of computing the arcs and figuring out where the "center" of the arc intersection is located. The Dodd article explains just how to do that. Peter Dodd has written a BASIC program which takes as input the three readings on the unknown plus the reactance of the capacitor and gives back an impedance in R+jX form. (He expects a fixed value of 50 for the resistor. If you use a resistor of a different value, you'll have to make a minor change to the program.) His method actually uses the voltage drop developed across the various components as measured via some diode detectors and a digital voltmeter, with power supplied by a separate transmitter. The RF-1 also measures the voltage drop using a diode detector (internally), but then converts that to a Z value for display. (Remember Ohm's Law?) So essentially the two methods are the same, except that using the RF-1 combines the functions of transmitter, diode detection, and digital readout all in one tiny box that fits in your shirt pocket. You do need to go back to your desk and/or computer to get the final result, but all you need to take to "the test site" (on top of your roof, maybe) is the RF-1, your SO-239 jigger thing, a pencil, and a scrap of paper. (I've even gone up on the roof forgetting pencil and paper. I tried calling down to my dog in the back yard, "Now, Ginger, when I come down I want you to bark 41 times, then bark 64 times, then bark 103 times." She doesn't quite have the hang of it yet.)

If you try this system, be aware of the following points. When you are determining the Z value of your reference capacitor (which of course will change at different frequencies), you get more accurate results from the Three Meter Method if you measure the capacitor in "C" mode and then convert the reading to a Z. For example, the capacitor I use reads "397 pF" on the RF-1. I convert that to reactance via the standard formula. At 7.040 MHz, the result is 56.9 ohms. I use 56.9 as input to the Three Meter Method. The RF-1 gives a reading of "55" for the same capacitor when in the "Z" mode. (This is not an error in the instrument, and makes perfect sense when you read the instruction manual about the internal processing that the RF-1 does.)

Also, be sure to check and perhaps reset the RF-1 frequency after you change the clip leads. The frequency will change slightly depending on the load that the RF-1 sees at the moment, and you want to make all your measurements at the same frequency.

And finally, you'll probably want to do some calibration of your "laboratory grade precision test instrument." In my case I took one of the 50 ohm 1% resistors that Autek supplied (!) and attached it to the "unknown" side of my SO-239 using the same rubber band technique described above. I took all the necessary measurements at 7.040 MHz, which is, as we all know, the center of the known radio universe. After converting the "C" of the reference capacitor to a "Z", I plugged the numbers into the Dodd program. The answer came out to something like 50.1-j0.8. Given the fact that my "unknown" could be anywhere between 49.5 and 50.5 ohms, this was better than I expected. However, I wanted to get the X value to exactly 0 so I played around with all sorts of different calibration techniques. I finally decided that the simplest method was to adjust the input value for the reference capacitor until the computed X came out to exactly 0. Now anytime I take measurements at 7.040 I just plug in that final value for the capacitor without bothering to measure it again. At other frequencies I have to at least compute the reactance of the capacitor again, and for absolute best accuracy even calibrate again using my standard resistor. Of course, I can't imagine ever having to change frequencies. Well, OK, maybe 3.560 or maybe 14.060. But definitely never at one of those "other" frequencies!

Just for completeness, I'll mention some of the other calibration paths I tried. You may want to play around in this area also. First I tried calibrating with a known length of coax at a variety of frequencies, to give a known value of complex impedance. The results were always within a few ohms of "right on", but I reasoned that in my case I didn't really care if my instrument gave a linear response over a wide frequency range; I wanted to be very accurate at a few discrete frequencies. Then I tried calibrating the RF-1 using the 1% resistors that are supplied. The results were definitely improved when reading just random R values, but didn't seem to make much difference when plugged into the Three Meter Method (although the size of the cocked hat was smaller). Then I thought I'd get an extra tenth of an ohm precision from the RF-1 if I took all readings in "C" mode, added back in the adjustment that the RF-1 makes, and convert to Z. Results got worse, plus it was a pain to keep track of everything, even letting the computer do the number crunching. If anyone comes up with a better technique, I'd sure love to hear about it.

But Wait, There's More

OK, so far so good. We have a relatively easy and fairly accurate method of determining impedance values in the form R+jX. But what we really want is to be

able to tell what's going on at the other end of a piece of transmission line of any given length. Maybe we want to take a reading in the shack but then convert that to the base of the antenna. Or maybe we have a paper antenna which we think will have a certain feed point impedance, and we want to see what it will be in the shack. You can use a Smith chart to do this for you. But we need a computer to use the Dodd program anyway, so why not a computerized version of the Smith chart. Enter the transmission line equation.

Now if you're like me (or at least like I used to be) your eyes glaze over when you see the transmission line equation in books like "The ARRL Antenna Book". It's full of all sorts of Zi's and Zl's and alphas and betas and nepers and radians, with a few hyperbolic sines and cosines thrown in for good measure just to make sure you don't get cocky and try to solve it using that latest pocket calculator you got in a Cracker Jacks box. Well, I'd come this far and I wasn't going to give up now.

I found several programs for solving the transmission line equation, and I bet there are a lot more that I never stumbled upon. One, the TL.EXE program that is bundled with the 17th edition of the Antenna Book, does a great job but only lets you go in the direction from the antenna to the shack. Another, TXFORM.EXE, is bundled along with the software for the Dodd article, but it only works in the opposite direction, and requires a rather unique way of entering the length of the transmission line.

Let me digress here for a moment. Although I did a bit of programming on large mainframe computers back in a former life, my knowledge of PC's is pretty meager. I have a PC at home. It's an IBM PC/AT. Vintage mid-1980's. I think the "AT" is for "Advanced Technology". It has a 286 processor (I think), 640K (that's K, not M) of RAM, and a whopping 20 meg hard drive. Oh yeah, and one diskette drive. 5.25 inch. Yessiree Bob, how much more "AT-ness" could a fella want?

Anyway, this PC was mostly being used as a door stop/dust collector. Boat anchor probably would have been more fitting, but I thought maybe the water would hurt the innards. However, the only version of a program to solve the transmission line equation that I could find which let you go in either direction was one written by John Grebenkemper, KI6WX, mentioned in chapter 27 of the Antenna Book and available from the ARRL for just a SASE. Only one problem. It was BASIC source code only, on a typed sheet. Well, I had already figured out how to run BASIC programs on my computer by using the Dodd program, so I figured I might as well learn how to write them as well. I found the BASIC language reference manual which came with my PC. Copyright date 1982. For all I know it was written by Bill Gates himself, back before he became a gazillionaire. I took the source code provided by Grebenkemper, typed it up, ran it, and lo and behold it worked. Verified the results by comparing it to the results given by the ARRL TL.EXE. I was happy as a clam.

Then disaster struck. I was bitten by the programming bug. Every time I ran across a new equation in the Antenna Book or some other reference, I'd think "Just a few more keystrokes and I could add that to MY program."

A Proud Father Talks About His First Born

I'll try not to bore you to death here. I've come to realize that every programmer thinks that his or her creations are the greatest thing since sliced bread. But this is my article, and I'll write about what I dang well please! (Of course, our editor may have a thing or two to say!) Any-

way, see Figure 4 for the input screen of the ZIZL.BAS program, and Figure 5 for the main results screen. After you enter the input for the first time, the program is kind of like a spread sheet in that you can change any input value (one at a time) and see the new results immediately.

There are also two secondary output screens which I won't show in the interest of brevity, although I do carry pictures in my wallet in case anyone asks. One shows the result of placing a tuner at the beginning of the line, which has the interesting effect of adding something called "reflection gain" to the power seen at the input of the line. (It's not free power. It's merely power that was reflected from the mis-matched load and then re-reflected back into the line from the tuner. It's all explained in the first few pages of Chapter 25 of the Antenna Book.)

The other secondary output screen lets you see impedance, current, and voltage at one or more points along the line, without having to change the length parameter for each new point. If you display points along the entire line from the load all the way back to the input (or at least for a half wavelength back from the load), you can get a good feel for the voltage and current standing waves that are present on a mis-matched line. You can also use this screen to see how rapidly (or slowly) the impedance changes at different points on the line.

What the Heck Is the Square Root of the Square Root of Negative One?

It was time to get back to the business of designing a phased array. Now there was a new roadblock. When doing parts of the design, you find that not only must you be able to measure a complex impedance value of the form R+jX, but now you have to do math with the results. I could handle add and subtract, that's pretty simple. Multiplication isn't too bad either, but I always had to refer back to my old high school algebra book to see where all the A*B's and C*D's went. Division seemed a little tougher, but still doable. And then the killer. The square root of a complex number. I can handle the square root of things like 25 and 36 without much trouble, even though I'm no child prodigy. But the square root of 14.27-j63.42? Nearly made my brain explode just thinking about it. But I persisted. Found out how to do complex square roots. (Actually it's pretty straight forward once you know the trick.) And since I was now the world's best BASIC programmer, I coded it all up in another program called COMPLEX.BAS. You can enter two sets of complex numbers along with the operation you want done, and presto!

And while I was at it, I coded up a few more little utility programs. The first one is almost so simple I'm even embarrassed to talk about it, but I find myself using it quite a lot. I could never remember the formula for the velocity factor of a piece of coax. Every time I tried to figure out how long a piece should be without first looking up the equation, the answer always came out to something like "984 feet", which I just felt wasn't right. So I wrote VF.BAS. You can enter any three of the four variables in the velocity factor equation, and the program will give you the fourth.

I also needed to figure out what two values of complex impedance would be if combined in parallel. For instance, what's the result of joining two pieces of coax going to two different antennas when the impedance at the input end of one is 25+j40 and the other is 19-j10? To do this you have to convert each impedance to the less common parallel equivalent form, combine like you do resistors in parallel, then convert back to the R+jX series form. Perfect excuse for another BASIC program.

An Example

So let's say you have a new antenna that, despite your best intentions, gives you an unexpectedly high SWR reading when you fire it up for the first time. You'd like to figure out what is going on in the complete antenna system, from antenna feed point to tuner input. You don't have much in the way of fancy test equipment, but you do have an RF-1 plus some computer programs that some blathering idiot told you about. You smile. You know the answers to all your questions are near at hand, except maybe the one about "Why can't a women be more like a man?"

First measure the impedance as seen at the input end of the coax using the Three Meter Method. You had the foresight to measure at least the electrical length and maybe some other parameters of the coax beforehand (I won't cover that here), so you can then use ZIZL to tell you what the antenna feed point impedance is. Let's say your numbers are 40+j10 (that looks familiar) at the input end, which translates to about 46+j16 at the antenna feed point. (This might be an inverted vee with the legs left too long. And actually the SWR at the input to the coax is low enough not to worry about. Criminey, this is just an example!) Now instead of going back up on the roof for the umpteenth time, you decide you'll just match the impedance at the input of the coax to a value your transmitter will be happy with. If you don't have an antenna tuner, you can use a simple L network to do the match. (Gee, I just happen to have a program to give you the component values.) You run LNET.BAS, or some equivalent, or maybe you just adjust your existing antenna tuner to get the best match and then measure the values of the L and C inside the tuner with your RF-1. In any case, you'll probably come up with something like a 0.23 uH series coil and a 226 pF shunt capacitor on the transmitter side, assuming a frequency of (what else?) 7.040.

To double check the values, take the impedance at the input end of the coax (40+j10) and add 0+j10 ohms because that's the equivalent reactance of the coil in series. Now what about the shunt capacitor? You handle that by realizing that the shunt C is nothing more than a reactance of 0-j100 in parallel with what you've got so far (40+j20), and that idiot mentioned above has a program to figure out two complex impedance values combined in parallel. Figuring 40+j20 in parallel with 0-j100, you come up with the impedance value at the transmitter side of your matching network or tuner. Amazingly, that value is 50+j0. Magic.

I Almost Forgot. The Antenna.

I haven't wanted to actually add up all the receipts, but I'm pretty sure I spent more on reference books from the ARRL than I did on aluminum tubing. I know for a fact that I spent more time at the keyboard than I did at the workbench. Nevertheless, there's an antenna here somewhere.

Nothing new here. I got the tubing from Texas Towers, via that nice man in the brown delivery truck. I was careful to remove all the burrs and sharp edges after making the hacksaw slots. Each antenna has four elevated radials. I tuned the radials to the correct length by treating each opposing pair like a standard half wave dipole and trimming to resonance (using my handy RF-1) before attaching all four to a common point. I decided to keep my antennas "floating" above any real ground attachment, although others advocate attaching the radials to any steel mast or other supporting structure.

The antennas are mounted at the roof line at the side of my house, at an elevation of about 25 feet above ground. Most of the radials go to various points on the roof, but one from each antenna stretches from the base to a convenient tree at the back fence property line of my lot. I made

the radials out of the smallest wire that I thought would hold up in the wind, plus I used clear nylon fishing line to hold them tight. When I called my wife out to survey the finished project I was careful to beat her to the punch by very diplomatically saying, "And look, honey, those tiny little wires and that fishing line high above your flower garden are almost invisible." She gave me a dirty look. Fortunately they're too high for the dog to reach. Also fortunately I haven't snared any passing seagulls with bad eyesight, at least not yet.

The antennas are oriented on a 65-245 degree axis. From here on the west coast that gives me a good shot at New England in one direction and VK-ZL land in the other. I chose to feed them with a 120 degree phase shift. From my preliminary calculations I hoped that would give me 1) almost a full dB of gain over the standard 90 degree phasing, 2) a null in the direction of the Russian 'F' beacon, which comes in particularly strong late at night at my QTH, and 3) a low value of SWR so I wouldn't have to use any matching network. I was overly optimistic on points 1 and 2. After taking some final measurements I determined that the gain at 120 degree phasing is only a few tenths of a dB above what it would be at 90 degrees, namely about 3 dB above a single vertical. (I'm not sure on this point, but I think the discrepancy was caused by all the nearby electrical "clutter" like gutters, downspouts, flashing, etc. Sometimes I fantasize about living in a tent on a desert island just so I could have a "pure" environment for my antennas. I mentioned this to my wife. She gave me a dirty look.) The null only has a minor effect on the 'F' beacon; it's strong when I point the beam in one direction and only "less strong" when I shoot opposite. Maybe the 'F' beacon isn't from Russia after all. Maybe it's a plot by those NorthWest QRP Club guys as payback for all the sunny weather we have in California. At least the SWR was low like I expected. Of course, the SWR is low when I transmit into my dummy load too, so that doesn't exactly tell me a whole lot about my antenna.

I'm happy so far with the results. It was rare for me to even hear European stations on 40 CW before. Now I hear them regularly, along with some Africans. I actually got my first EU QSO on 40 with it. He was from Norway. There wasn't a particularly large pileup on him, so I just persisted and he finally came back to me. I was so excited that I just sent "QRP CA", my name, and then "TU" about a dozen times. I could hear the smile in his fist when he came back to me with "TU for the TUs OM, but what is my RST?". I had forgotten to send that. Pretty embarrassing. Just like my very first QSO as a novice. Big fun!

I also seem to have pretty good coverage in other directions. JAs, VKs, and ZLs are all pretty common, as is most of South America. I do have a weak spot right at the southern tip of South America, so all those pesky hams in Tierra Del Fuego who have been persistently calling me because they want one of my rare State of California QSL cards will just

Free To a Good Home

I'll gladly make available the BASIC programs that I mentioned in this article, with the exception of the Peter Dodd Three Meter Method one. That program has a copyright on it, so I wouldn't feel right about re-distributing it without the author's permission (and maybe that of the ARRL). You'll probably want to buy the book anyway. I found it well worth the money.

I also have a few others that might be of interest, especially if you want to design a phased array system. The complete set is:

ZIZL - Everything you could ever want to do with the transmission line equation,

in addition to being the greatest thing since sliced bread. Really. I mean it.

COMPLEX - Lets you easily do arithmetic with complex numbers.

VF - Velocity factor equation in any of the four forms.

ZPAR - Calculates what the result will be of combining two complex impedances in parallel.

LNET - This is a simplified version of the methodology given by Robert White, W6PY, in "The ARRL Antenna Compendium Volume 2." His technique lets you design any kind of matching system (PI, T, or L, high pass or low pass) based on a desired phase shift rather than the more common method of choosing a Q value. This stripped down program just does the calculations for a low-pass L network.

ZCHAR - Computes the characteristic impedance of a piece of coax, given two sets of measurement values. Described in the Antenna Book, pg 27-27 (17th edition).

ZMUTUAL - Calculates the mutual impedance between two (only) antennas, given measurements as described in Chapter 8 of the Antenna Book.

ZFEED - Once you know the mutual impedance, this program will tell you the feed point impedance of each (of two only) antenna, which will vary with the phase angle that you want to use.

ZZSWR - This program is based on a clever equation that is found in the Autek RF-1 instruction manual. Given total Z and SWR values, this program will give you a rough estimate of the R and magnitude of X (but not the sign of X). For example, if the Z reading is 50 but the SWR reads 2.0, you know there has to be some reactance in the impedance. Otherwise the SWR would be exactly 1.0. The accuracy is limited because of the limitations of the RF-1 (and most other SWR meters, for that matter) in giving a very precise SWR value, but this at least gives you some ballpark feeling for the numbers.

Each of these programs is available as BASIC source code only. I feel you should be able to read the code and see how I did things, maybe to learn and maybe to catch any mistakes I might have made. The complete set is contained in an archive file named RFFUN.ZIP, available for download from the NorCal web page. (Thanks go to Jerry Parker, WA6OWR, for making that happen!) If you don't have web access, feel free to send me an email at bagardn@ibm.net and I'll send them to you.

Acknowledgments

Besides the contributions of Dodd and Grebenkemper mentioned above, I would have been completely lost without the work of both Roy Lewallen, W7EL, and John Devoldere, ON4UN. Chapter 8 of the Antenna Book, written almost single handedly by W7EL, really does a great job of explaining what's going on in a phased array system. W7EL also has a paper in the Antenna Compendium Volume 2 which shows a way to calculate the length of feed line to each antenna for a given phase delay, assuming you choose to feed with unequal length lines (which I did).

The book by ON4UN, "Antennas and Techniques for Low-Band DXing", covers much of the same material but presented in a different way. It was really helpful to be able to read the two different author's presentations of the same material. When I didn't quite understand one, I'd turn to the other. Also, the ON4UN book contains a large number of worked-out examples.

ON4UN also makes available a software package containing many programs designed to aid in the planning of a phased array system. I forced myself not to order them, because once I got started I found that I really enjoyed the challenge of figuring out the equations and coding the programs myself, even though I did

nothing to advance the radio art and probably only ended up writing a slightly different version of something that had been written hundreds of times before. (Kind of like building your own QRP rig versus buying retail.) Having said that, I'll probably order the ON4UN software. The price seems very modest considering all that is provided, and I've already got some ideas for some more complex four element systems, for which the programming becomes more complex. It would require some more aluminum tubing and more elevated radials, though.

Now if I could just do something about those dirty looks from my wife. Have fun and happy phasing!

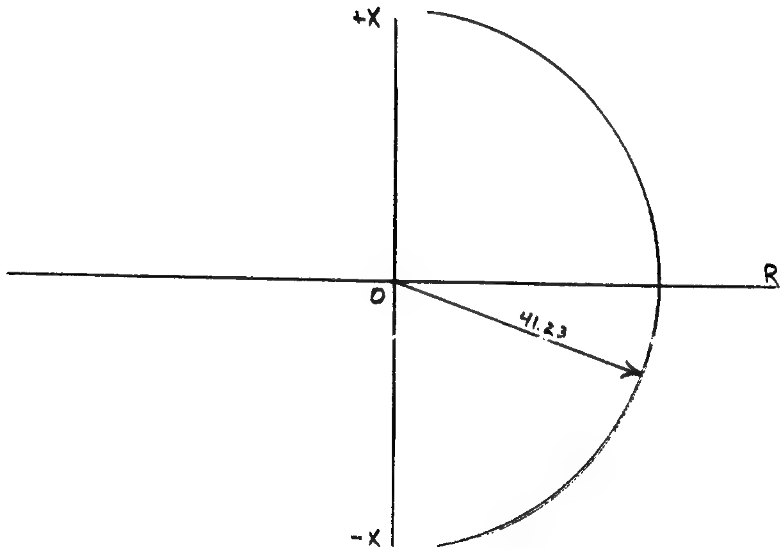

Fig. 1

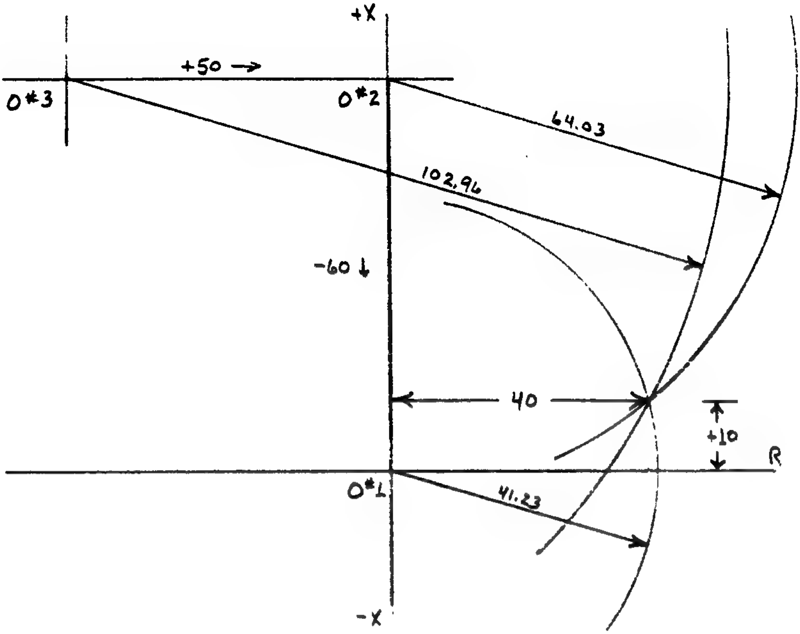

Fig. 2

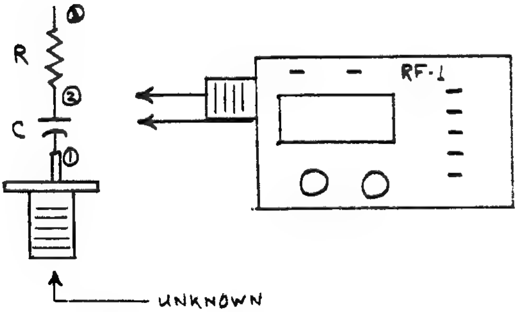

Fig. 3

```
Frequency in MHz?  7.04
R, X in (+/-) ohms?  40.10
At input or load (i/l)?  i
Input power in Watts [default equiv 1 Amp at load]?  5

Coax Type:    1 = RG-8X  Foam Std
              2 = RG-8X  Custom
              3 = RG-58 Solid Std
              5 = RG-59 Foam Std
              6 = RG-59 Custom
              7 = RG-213 Solid Std
              9 = Other?  9

Coax characteristic R0, X0?  51, -1
Velocity factor? .75
Attenuation in dB/100 ft., at frequency in MHz?  .89, 10
Length in feet (or append 'w'/'d' for wavelengths/degrees)?  .453W
```

Fig.4

```
Frequency = 7.04 MHz

Coax char Z = 51  -1          Velocity factor = .75
Attenuation = .89 dB/100 ft. at 10 MHz
Length in feet = 47.468       Wavelengths = 0.453          Degrees = 163.080

                       Input                         Load
R, X:                  40.00    +10.00               46.40    +16.62
Z, SWR:                         41.23     1.41                49.29    1.45

P, I, E:               5.00     0.35      14.58      4.58     0.31     15.49

Loss = 0.35 dB Matched-line  +  0.02 dB SWR  =  0.38  dB Total

Approx. max line voltage  =  19.25 (rms),  27.22  (peak),  current  =  0.38
New Frequency  (f), Input R and X  (i), Load R and X  (l),
     Input Power (p), coax (z/vf/db), or Length (len),
     or Tuner screen (t), Steps screen (s), or [quit]?
```

Fig. 5

ScQRPion Visual SWR Indicator (SVSI)

by Dan Tayloe, KK7BD
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Phoenix, AZ 85048

The ScQRPion Visual SWR Indicator (SVSI) is an offshoot of the SWR bridge I currently use. It's designed for QRP use in the 1 to 5 watt range and is extremely small, lightweight, cheap (under $5), and reasonably accurate. Perfect for the Spartan Sprint! And it always presents a reasonable load to your rig, no matter how bad the mismatch. Nothing worse than blowing your finals in the field, after all. Controls consist only of a small LED and a DPDT switch, and it's a perfect fit for building right into most QRP rigs.

Background

I have been pursuing QRP heavily now four the past year mainly due to the untimely demise of my Kenwood TS820 in my move to Phoenix.

I love to build. Using this death as an excuse to build up a CW station from scratch, I began building QRP rigs.

From the beginning, I found my old Calrad SWR bridge (circa 1971) was too insensitive to use with my first homebrew rig, a 40m 2 watt transceiver.

One of my old ARRL books (QRP Classics), contained a schematic for a resistive bridge for making SWR measurements using low power. I guess in the good old days "low power" did not mean what it does today. It was basically a 50 ohm load across the transmitter from which a 680 ohm resistor was used to sample some signal which was then used to feed the resistive bridge circuit.

Well, drive this circuit with 2 watts (14.14v peak), figure in the voltage loss from the 680 ohm sampling resistor feeding a 50 ohm bridge, and the voltage drop in the bridge itself (divide by 2 for the bridge) and you have 0.48v left at best case (open or shorted antenna) to drive the detection diode. With 2 watts, you could detect an open or a short, but almost nothing inbetween! The SWR loooked great for almost everything!

I eliminated both the 50 ohm load and the 680 ohm sampling resistor and fed the power from the rig directly into the resistive bridge instead. I now had plenty of signal with which to measure SWR.

The Circuit

The one big advantage a resistive bridge such as the SVSI offers over any other kind of SWR bridge is that it protects the rig from the mismatches seen from the antenna tuner during the tune up process. No matter what the mismatch is at the antenna, the rig will see a load somewhere between 33 ohm (antenna shorted) to 100 ohm (antenna open). When the antenna is a perfect 50 ohm, the rig will see 50 ohm also.

In the circuit shown, R1 represents as many smaller resistors in parallel as necessary to dissipate the power from the transmitter. When matched to 50 ohm, each R1 will dissipate a quarter of the input power, with the antenna also receiving 25% of the power.

In my SVSI bridge, each R1 is four 200 ohm 1/4 watt resistors in parallel. Not quite 50 ohm, but close enough for me. This gives an intermittent input power rating of 4 watts for the bridge. Since resistors don't like to be run continuously at more than 50% rated power, the rating drops to only 2 watts of continuous input power.

Other resistor combinations can be used for higher power levels. For example, six 300 1/4 watt resistors for each R1 would provide for 6 watts of input power.

The novel part of this circuit is the use of T1 and a LED for the SWR indicator. Since this is a bridge configuration, when the bridge is balanced (i.e.: the antenna is 50 ohms), the voltage across the primary of T1 will be zero.

Therefore, since the LED is driven off the RF voltage across the bridge, a high SWR will indicate as a bright LED, a 1:1 SWR as the LED completely off. Thus it keeps with the age old tradition of "tune for minimum smoke" or in our case, minimum light. After tune up is done, simply switch the bridge out of the circuit.

In this design, I could have placed D1 and its resistor directly across the bridge and skipped using transformer T1. However, the LED does not conduct below 1.7v, which is far worse than the typical 0.5 to 0.7v of a normal diode, and the SWR sensitivity would be lousy. This is after all QRP.

At 5 watts input power (22.3 v peak), you are working with 11.2v maximum across the bridge compared to 1.7v threshold of the LED. At this power level, the LED will go out in the range of 37 to 68 ohms at the antenna port. This is not great, but for crude purposes, it might be ok. However, for two watts, 1.7v threshold detection is a lot of sensitivity to give up. At this power level, the LED will go out in the range of 30 to 81 ohms at the antenna port, which is not great either.

In comes T1. This is used to step up the voltage across the bridge by a factor of three to the LED. This effectively brings the sensitivity of detection in the LED down to 1.7/3 or just under 0.6 volts. This improves the zero LED range to 45.1-55.3 Ohm for 5 watts , 42.5-58.7 Ohm for 2 watts, and 40-63 Ohm for only 1 watt input power. Much better!

I used a small, clear LED so that I could tell exactly when the LED was totally out. Clear provides more contrast than a colored LED, especially under high light conditions.

I used a four winding core to get the 3:1 voltage step up. It may work just as well to use a 36 turn winding (36 turns almost fills the core using # 28 enamel wire) for the LED side, and a 12 turn winding on top of it for the winding across the bridge. The idea here is not so much an efficient impedance transformation, but rather just to step up the voltage. The diode should represent a rather high impedance anyway just as it is about to turn off, which is really the only point we really care about anyway.

T1, a FT37-43, uses a ferrite core as a broad band transformer. Don't try to substitute T37-2/T37-6 (or T50-2/T50-6) type cores since they will not produce enough inductance to make a satisfactory transformer (been there, done that in my younger years). The larger FT50-43 will work fine also.

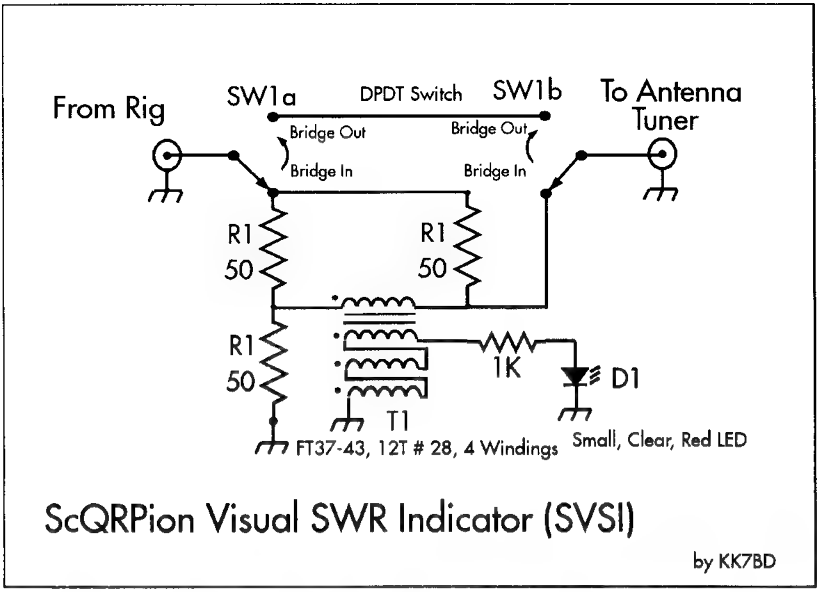
If you really find winding core yourself one to much challenge, I can provide a prewound one for $2.00 (it keeps the kids busy!).

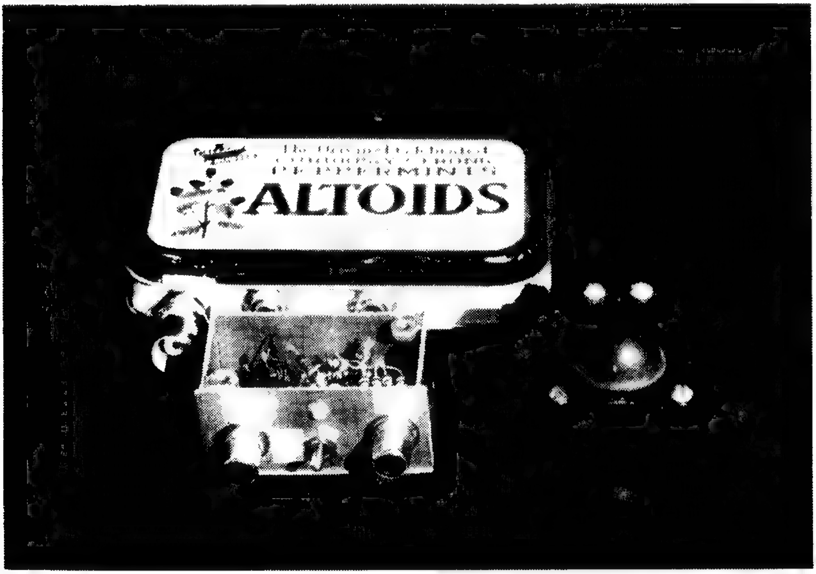
The resulting SWR bridge is extremely lightweight and cheap to build. Perfect for Sprints. If it gets lost in a snow bank in the FYBO contest, you are not out much.

I build the box for mine out of a few scraps of PC board. Total cost was under $5.00. [Building hint: Custom boxes are extremely easy to build using double sided PC board cut using a heavy duty paper cutter.]

Thanks to fellow ScQRPion members Joe, KC7NEV, for encouraging me to submit this article and Floyd, KQ7X, for the neat photography work.

Comments? I can be reached by email:
(Dan_Tayloe-P26412@email.mot.com)
or regular snail-mail (Dan Tayloe, 14240 S. 7th St, Phoenix, AZ 85048).
Have Fun!
72, Dan Tayloe, KK7BD, Phoenix, AZ





ScQRPion Visual SWR Indicator, photo by Floyd Smithberg, NQ7X

QRP To The Field

Saturday April 26, 97, 1300 utc to 0100 utc (Sunday)

Single Transmitter, declare best (8) continuous hour period for contest scoring.
Open to all Radio Amateurs, all modes, and all bands except WARC.
Once started, maintain the same power and location categories.

Exchange: Phone RS and State, Province, or Country
Digital (CW, etc.) - RST and S, P, or Country

QSO Points: 1 watt or less out - 10 points
5 watts or less out - 5 points
over 5 watts - 2 points.

Multipliers: Field location (Battery power & Temporary Antennas) 4X
Home location (Commercial power & Permanent Antennas) 2X
Home-brew Equipment = 3X;
Commercial Equipment = 2X.

Final score: Band per Mode QSO points X the location multiplier X the equipment multiplier. Add the Band per Mode totals to figure the final score.

Awards: Certificates to the TOP TEN scoring stations and to PARTICIPANT entries with 20 or more contacts (include a 9x12 envelope and 3 units of postage for participant certificate). Send Logs with station and location descriptions to: QRP To The Field, 6822 131 Ave SE, Bellevue, WA, 98006-4038, by May 15, 1997. Include a #10 SASE for results. All contest committee decisions are final.

Last year entrants were encouraged to operate from places of historical interest or significance. This year we are encourageing entrants to set up and operate from places where "strange" things have occurred. If you live near a Sasquatch sighting, a UFO sighting, or a "secret" military installation, this is the type of place we are talking about.

As an example, Monte Stark, Bob Follett, Paul Harden and Doug Hendricks will be operating from Area 51 in Nevada. They will fly in to Las Vegas, rent vehicles and then proceed to their destination at Area 51. Please listen for their station, which will be calling CQ 51 as an identifier. All stations worked will be qsled with a special qsl card to honor the event. (Providing that they make it back.). QSL via Paul Harden, NA5N, 120 Garden Circle, Socorro, NM 87801.

A Treasure from a True Friend

by J.L. McClurkin, W7JDZ
1111 Cameron Ave.
Idaho Falls, ID 83402

When I saw the nomination for Jim Cates, WA6GER for the QRP ARCI Hall of Fame on qrp-l on the internet, it jogged me into writing about some of the many qrp adventures Jim and I have had over the last 32 years.

When I first met Jim I was an avid vhf-er transplant from southern California. The only ham that I knew in the Sacramento area was a young high school senior who was a builder and about to head off to college. I made the remark one day that I wure was going to miss him because he was a builder like myself and now he would be gone. He told me to get in touch with a Jim Cates, WA6GER. I ran into Jim on 2 meters soon after that and he invited me to come to his shack (believe me it was a shack - hi). I almost put off the invitation but decided if I didn't do it right then I many never meet a new friend.

Wow! When I got to Jim's place I decided this is my kind of guy. All kinds of little gadgets and what have you, mostly home brewed. Some worked and some didn't. I believe Jim had spent a lot of time on the lower bands on cw prior to meeting me. We had a ball on the vhf bands together. We built up equipment for 432 MHz and used to work cross-band duplex with the intent to get more people interested in the 432 MHz band. We converted APX-6's to somewhere in the 1215 MHz band and used those as our private intercom system (there was no one else on the band). On one vhf field day Jim took his APX-6 to a FD site some 50 miles from my QTH and we had a successful exchange. Jim also constructed a 3 pound coffee can directional antenna, and used the APX-6 mobile and we had a 2 way exhange.

Twenty four and a half years ago I moved from Sacramento to Idaho Falls, Idaho. Jim and I have stayed in very close contact all this time. Jim is a true friend even though I have blindfolded him when taking him to my favorite fishing holes. The scoundrel has even caught a bigger fish than I. His motto "Want to catch a big fish, use a big lure", and it worked!

We have stayed in touch via 40 CW, vhf packet (direct 2 way before packet got crowded with BBS's), and with RTTY on 40. We have had contacts with Jim's HB QRP rigs several times. One rig was a 6AQ5 rig and the other a 2N3866. I have saved the QSL card from Jim dated 1975 using the 2N3866 rig because it exhibits the fun and games Jim and I have had together all these years. By the way most of our vhf adventures were in the QRP category also.

Naturally I would not hesitate to second or vote for Jim as a candidate for the QRP Hall of Fame. NorCal has done so much to rejuvenate QRP activity that I find it just amazing. I kidded Jim when he first told me of the starting of the NorCal QRP Club. I told him since he was retired that he would get a lot of work to do as clubs always say, "You're retired and have a lot of time on your hands, why don't you do xxxx". To quote a saying that seems popular these days, "Been there, done that."

[Editor's note: The above was excerpted from a letter that Mac wrote to me last fall. He closed it with the following paragraph.]

I am enclosing the QSL card for you to copy. I was not sure shat kind of copy method would work if you wanted to reproduce Jim's card for QRPp. So you do it and please return the card, as it is one of my treasures from a true friend.

Mac, W7JDZ

SACRAMENTO COUNTY

WA6GER

JAMES W. CATES
3241 Eastwood Road
Sacramento, Calif. 95821

Jim Cates QSL Card from 1975

Radio W7JDZ Confirming
our QSO of JAN 12 19 75
at 0600 GMT 7.080 mc
ur CW sigs RST 579
Xmtr 2N3866 2 wts INPUT
Rcvr DRAKE 2C
Ant DIPOLE

MAC: AMAZING, THESE QRPP RIGS. LET'S MAKE SKED EARLIER — SIGS SHOULD BE BETTER — MORE QRO & LESS QSB. OR SOMETHING. MAYBE 0930 UR TIME?

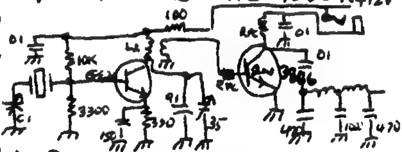
(✕) Pse QSL Tnx (·)

TNX MUCH FB QSO. JIM

NU-PRINT 322 Page Blvd., Springfield, Mass.

MY RIG: A TRUE STORY BY JIMMY C.

THIS IS MY RIG. MY RIG WORKS GOOD. MY RIG WORKS MAC. MY RIG WORKS MAC GOOD!!



A PICTURE OF MY RIG →

MY RIG WORKS MAC GOOD ON SUNDAY MORNING. WANNA HEAR MY RIG WORK MAC GOOD? HEAR MY RIG NEXT SUNDAY ON 7080 AT 0930 MST.

The "Info" side of Jim Cates, WA6GER QSL to Mac McClurkin, W7JDZ

Resonant Speakers for CW: A Mounting Technique for a Speaker in a Tube

by Bob Barry, WB2CWA
Essex Junction, VT

I was inspired to tinker by a note that was posted to qrp-l... a note by Gary Surrency AB7MY on Oct. 2, 1996 on resonant speakers for CW. These work well with LM380 and LM386 chips. His work referenced the 13th edition of Hints and Kinks for the Radio Amateur pages 9-16, 9-17. The accoustical structure of the resonant cavity is a quarter wave tube with an accoustically reflective end plate. There is a 1/16th to 1/8th inch gap or vent around the circumference of the tube at the reflective end. The speaker is mounted at the other end of the tube aiming into the tube. The reflected wave augments the speaker cone movement at resonance. The distance from the reflecting plate to the surface of the speaker cone is calculated with the following formula:

$l = 3406/f - 0.4d$

where: l = length of the tube in inches

f = resonant frequency of the tube in hertz

d = inner diameter of the tube in inches

example: 3.74"=3406 / (750Hz) - 0.4 x 2.0" (i.e. l=3.74"for 750 Hz)

4.07"	700 Hz
4.48"	650 Hz
4.88"	600 Hz

I wanted to build one with a 2 inch diameter that would be adjustable from about 600 Hz to 800 Hz for experimentation. If my mechanical design was not simple I knew I would not build it. I had a 5 inch piece of schedule 40 PVC and bought a 2 inch diameter Radio Shack speaker p/n 40-245. It was a very loose fit inside the tube. The PVC had a 2.04" I.D. and the speaker was 1.97" in diameter. For a speaker mounting surface inside the tube I cut an additional 1/2 inch long piece of the 2 inch PVC tube (more of a ring than a tube). I then cut about 80 degrees of arc from the ring leaving a "C" shaped piece. This C shaped piece can be compressed to a smaller diameter with finger pressure to fit inside of the main tube. Its spring force and friction hold it in place nicely. It can be slid to any position down the tube to adjust the resonant frequency.

Place the speaker face down on the C ring. The C ring should still have about a 1/8 inch gap at the opening of the C. Route the wire from the speaker down through that gap to the bottom or back of the assembly. Install another C ring like the last one on the top side of the speaker to hold the speaker in place. Mount the accoustically reflective end plate (plastic, wood or metal) at the end of the tube using 3 screws and three 1/8 inch spacers. Gary used three small feet (pennies) and stood the tube on a table top. I found that a 1/8 inch vent was a little more efficient than 1/16 inch gap. "Your mileage may vary."

Before the second C ring is installed it is easy to remove the speaker to adjust the placement of the first C ring until resonance is right where you want. You will notice during this experimental phase that the sound pressure level decreases by more than 10 dB when you remove the speaker from the cavity. At resonance the electrical impedance of the speaker when mounted in the cavity increases because of motor/generator action between the coil and magnet as the reflected wave augments the speaker cone movement. You should see an increase in AC voltage across the speaker terminals as you sweep the freqency through resonance assuming that you have something greater than a

zero ohm output impedance on the signal source.

If the fear of a complicated speaker mounting fixture has kept you from experimenting with resonant speakers I hope that this simple double C ring design will set you free to play with one. I had fun with this project and I hope you do too. 72, Bob

OHR100 Review

by Chuck Adams, K5FO
adams@sgi.com

When the qrp-l group buy came up at Oak Hills Research, I couldn't just stand around and not get in on the fun, so called Oak Hills Research and sure enough in a week comes the little brown box on the little Brown truck. I didn't see the UPS guy/gal show up at the doorstep but there is was when I got home from work. This was on Wednesday evening but I held off opening the box until Friday night. Such discipline. Did I mention that OHR takes plastic? It helps. Mast~~erC~~ard and Visa cards spoken there. He also takes personal checks and the old money order.

I thought that I'd build this one with pictures, so as to give you the results up close and personal. Also visit OHR's web page at the end of this review.

The PC board shop that Oak Hills Research uses has got to be one of the top 10 in the world. The quality is outstanding. Green solder masked and with the white silkscreen it is a joy to work with and doesn't cause a great deal of strain on the eyes. The registration and alignment of the silkscreen along with the crisp fine print makes the assembly process a joy. The top kits with great boards are OHR, Small Wonder Labs, Wilderness Radio, NorCal, and S&S Engineering just to name the leaders of the pack.

One of the first things that I do is to get a plastic school box and put the parts in it. This does a couple of things for me. Keeps all the parts in one place so that I don't lose anything. Also allows me to stop at any point and continue later without having to scramble around putting things up and later unpacking to start back up on the project. Another thing, don't break open any bags until you need something in them. Resistors are in a separate bag and the bandpack is also in a separate bag. I haven't had OHR short me on anything except one socket in all these years and although OHR and others have you open the bags and do an inventory first thing, I never have. I do it as I go along. I find it easier in the long run. Now it can get scarey sometimes as it did for me in this kit, as R105 (15 ohms) is in the bandpack and not in the resistor bag. This is not mentioned in the manual (yet) and R105 is missing from the parts list but magically appears later in the manual when you get to putting the bandpack parts on the board. So just relax.

This kit, as the other OHR kits over the years has step by step check 'em off as you go instructions. For the inexperienced builder there is a pictorial on winding toroids (there are 9 in this kit) in the additional 10 pages and there are two pages of 'parts pictorials' showing drawings of each part. This is like the old Heathkit manuals and in fact Dick W. uses an illustrator that used to do the Heath manuals if I remember correctly. I found that for an hour or so after winding a number of toroids that the thumb and first finger on the left hand are sore. I think that Dr Rick in VE3-land has a special term for this like 'toroid-tendinitis'.

I went through the assembly process without a single hitch. The instruction manual is complete and fairly detailed so shouldn't be any trouble for the builder. Just use a good 25W soldering iron with 63/37 or 60/40 0.031" diameter solder suitable for electronic assembly. Don't use any larger iron and use the best small tip you can find. I wish Ungar still made the PL-823 iron clad tip. I have been using the one that I have on the Weller for all the kits but the S&S digital VFO that had SMT parts that I have built the last five years and the tip is still as good as new (well almost). No pitting and no visible wear that I can tell. A $2 investment that has paid off all after all these years many times over. If you run across one or more of these at a surplus place or at a swapmeet by all means latch onto it. Maybe we outta start a writein campaign to Ungar to bring them back.

The parts are first class. The tuning pot is a sealed 100K part made by Precision in Canada. A real nice pot and I like the feel. It is wirewound and will last longer than the carbon deposit type pots that I have used on other rigs.

One thing that I still do and did even back in the Heathkit days, but this is recommended only for the experienced builder. Most kits will have you precut a wire that goes between two points. I don't. I strip the covering from one end of the wire, solder it and then place the wire along the desired path until I get to the final point. Then very carefully (remember the other end is already soldered) cut the wire with enough margin to allow stripping and soldering. This gives me an exact length that is usually different from the one in the manual. I think it comes out neater and you can judge this from the photos showing the wiring harnesses. Again, experience and care is needed here and do this only if you feel that you can do this without error or have some spare wire available in case of error.

So if you are going to spend $130 for a 40M transceiver you have several choices. This OHR100 transceiver is I think a good one and will last the builder a long time. It will do the full 5W for those that have just got to get the last watt out to the antenna allowed by QRP levels. Other rigs are in the 1W to 2W level. And of course, with the adjustable output and when conditions are more favorable, you can crank the power down to the milliWatt level. I haven't seen how low it will go but it should be under 10mW and at that level getting on the air will indeed be a challange.

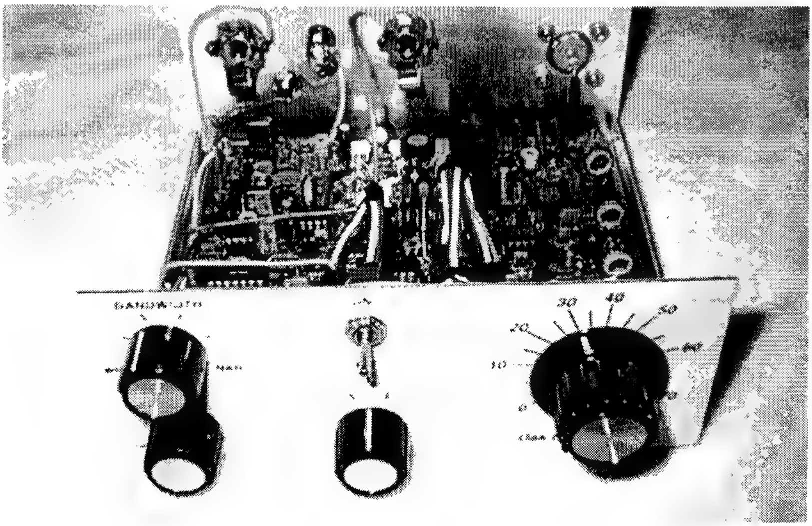
I fired the OHR100 up and aligned it in short order and nothing was installed incorrectly and no problems encountered. Having a scope and a frequency counter will help in the alignment.

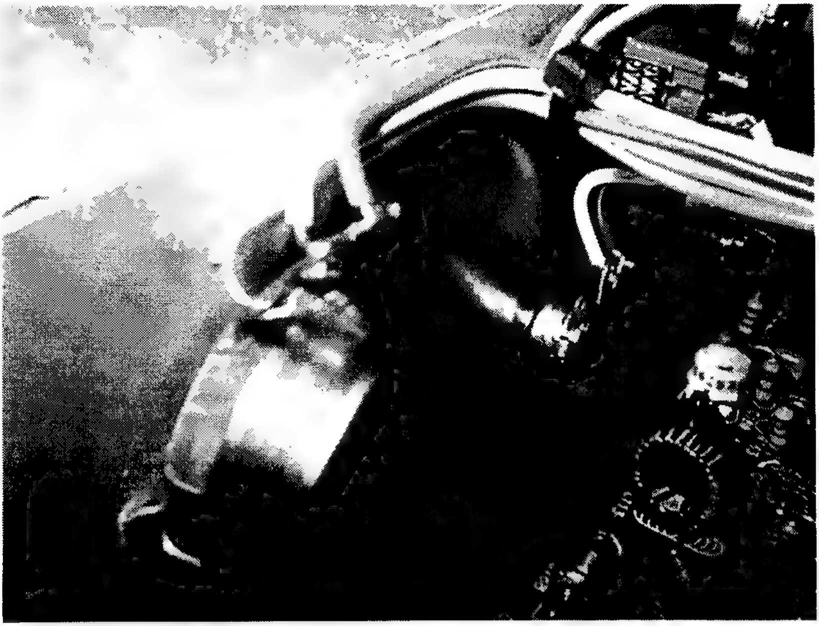
I put it on the air late Sunday at 2W and worked a couple of stations stateside. Early Monday morning I was hearing a lot of DX in Europe, Japan, Australia, and the receiver is very good. The selectivity is excellent and will help dig out the weak ones. The QSK and AGC are excellent as OHR has always been good at doing these things. Sidetone is generated with an audio sine wave generator and has adjustable level and adjustable tone frequency internal to the rig.

This reviewer has invested a lot of time and money in a lot of kits including a lot of OHR stuff. It may seem that I work for OHR, but I don't. I have a full time job already. I do this stuff for fun.

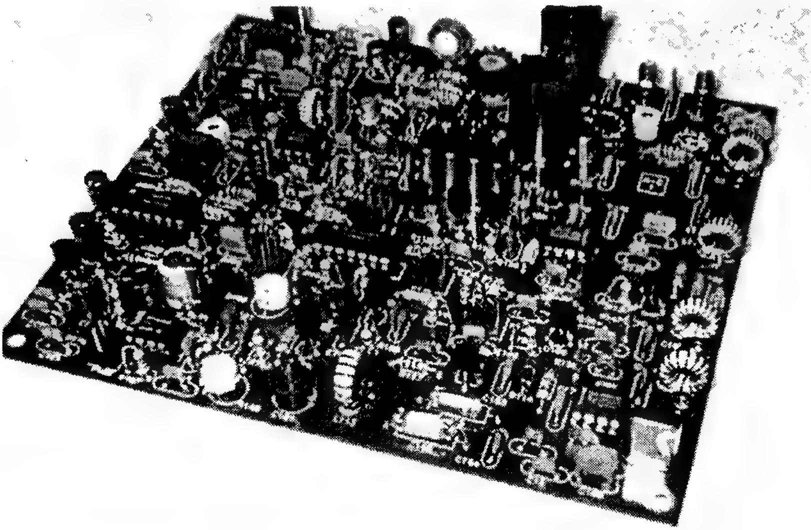
Oak Hills Research OHR100 40M CW Transceiver Kit
MFR: Oak Hills Research
Address of MFR: 20879 Madison Street Big Rapids, MI 49307
Phone Number: 616.796.0920
Designer: Dick Witzke, KE8KL
Model: OHR100
Size: 14.4cm x 12.3cm board
Weight: 23.4 ounces for assembled kit

with case
PC board: Double sided plated-through, solder-masked and silk-screened PC board
Manual: 19 pages 8.5x11" double sided manual + 10 pages parts listings and schematics and illustrations
Power: 12 to 15VDC
RX Drain: 65mA
TX Drain: ~800mA on transmit for 5W output
Ant Connection: SO-239 connector
Pwr Connection: Coaxial DC Power Jack
Key Connection: 1/4" Mono Phone Jack
Ear Phones: 1/4" Mono Phone Jack
Modes: CW only
Kit: Yes. Complete with case and internal parts
Bands: 40M with other bands (30M and 20M available)
LO/VFO: Osc with 3.712-3.782MHz out (7.000-7.070MHz tuning)
Drift: Less than 500Hz in 20 minutes from a cold start with cover removed at 65 degrees F.
Dial Range: Marked 0 to 70
RX: SuperHet
XMT: Yes. Rated 5W. Measured 5W into dummy load and 5W into antenna at 12.88V.
Filter: Four crystal filter at 9.000MHz
Selectivity: About 1100Hz-400Hz variable
RIT: Yes.
Gain: Audio.
AGC: Yes
Preamp: No
Atten: No
Builtin SPKR: No
Meter: No
S Tone: Sine wave generated at audio levels. Adjustable level.
VFO: Yes. Covers 70KHz or a little more of the 40M band.
Output: 5.0W adjustable with external knob to lower levels
Internal Keyer: No.
QSK: Yes
Price: $129.95 US (see web page http://www.ohr.com/)
Availability: From Oak Hills Research at above address.
Options: None known at this time
Date of Review: February 18, 1997
Author: Chuck Adams, K5FO
Comments: Another super rig from Oak Hills Research.





Note K5FO's method of cabling the wiring on the OHR 100



The Populated OHR Board before mounting in the case

The E-DIAL:
An Electronic Dial for Varactor Tuned QRP Rigs

by Bill Jones - KD7S
83 Redwood Ave.
Sanger, CA 93657
kd7s@valleynet.com

Many QRP designers have opted to use VVC (Voltage Variable Capacitor) diodes as the main tuning element in their rigs. While this approach circumvents the shortage and high cost of conventional air variable capacitors, it comes with a price. Consider a design with twenty or more kHz of tuning range controlled by a conventional 270 degree potentiometer. Fine tuning can be very difficult to achieve as the tuning rate is much too fast. As a result, many builders have opted to use a 10-turn potentiometer instead. While this certainly slows the tuning rate, it presents another problem. That is, how can you tell what frequency the rig is actually tuned to without a turns counting dial and cross reference chart?

The E-DIAL solves these problems in a very simple and cost effective way. It is the electronic equivalent of a conventional sliderule dial.

The circuit consists of three LM3914 dot/bar graph display driver ICs driving three 10-segment LED bar graph displays stacked end-to-end. Electronically, the E-DIAL is an adjustable, expanded scale voltmeter using LEDs as the display. The voltage to be measured comes from the wiper contact on the main tuning control pot.

Construction

The E-DIAL circuit can be built on a homebrew PC board or wired, point-to-point on a piece of perfboard. For experimental purposes it could even be built on a prototyping board.

Wire board as described below. Follow the steps in the order shown. After each step is completed and checked for accuracy, mark it with a highlighter. That way you won't run the risk of missing a step. Be wary of solder bridges. There are several traces which are placed rather close to one another.

1. Install the six wire jumpers, Jmp1 through Jmp6.
2. Install three low-profile sockets for IC1, IC2 and IC3 making sure they are properly oriented on the board. With the component side of the board facing you and the pads for the LEDs on the top, the notches in the sockets should face to your left. Do not use sockets for the 10-segment LEDs.
3. Install the six fixed resistors.
4. Install the 10 uF tantalum capacitor.
5. Install the two 10k ohm, 10-turn Cermet trim pots.
6. Solder the three 10-segment LEDs in place. Pay very close attention to the polarity of these devices. If they are installed backwards, the E-DIAL will not work. You may want to start with a single LED first (LED1.) If it lights up when the circuit is finished, you can install the remaining two.
7. Connect a red wire from the hole marked Vcc to the output of a well regulated power source on the transceiver's PC board. The best place to obtain this voltage is from the source that feeds the main tuning potentiometer. It must be at least as high as the highest possible voltage on the main tuning potentiometer's wiper contact.
8. Connect a black wire from the hole marked Gnd to the ground bus on the transceiver's PC board.
9. Connect a wire from the hole marked Input to the wiper of the main tuning potentiometer.

Initial Tests

Do not install the three LM3914 ICs yet. They will be installed only after some initial tests have bee performed.

10. Power up the transceiver and measure the voltage at pin 3 of each LM3914 socket. This should be the same as Vcc on the E-DIAL circuit board.

11. Check the voltage at pin 5 of each LM3914 socket. The voltage should vary as you rotate the main tuning control potentiometer.

12. Power down the circuit (transceiver and E-DIAL) and insert all three LM3914s in their sockets. Pay very close attention to the orientation of these chips to insure you do not plug them in backwards.

13. Restore power to the transceiver and the E-DIAL. As you rotate the tuning potentiometer, the LED display should move up and down the scale although it is unlikely it will move from end to end on the dial.

Alignment

The following steps will walk you through the alignment of the E-DIAL so the display will correspond with the full tuning range of your transceiver.

14. Rotate the main tuning control on your transceiver to its lowest frequency setting (generally a counter clockwise rotation of the potentiometer.)

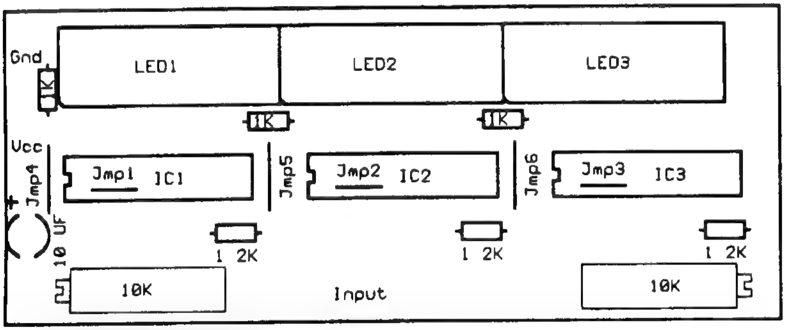
15. Adjust R1 on the E-DIAL PC board so the left-most LED just barely lights.

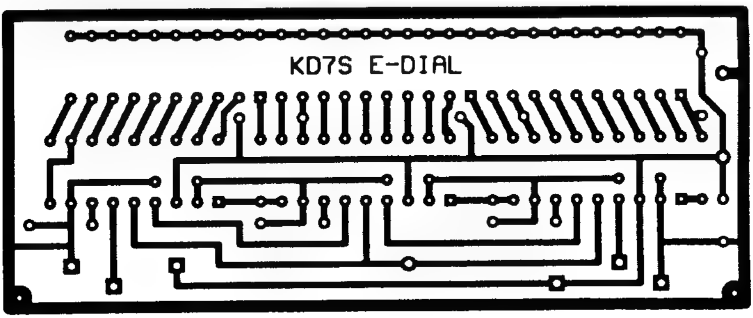
16. Rotate the main tuning control on your transceiver to its highest frequency setting (clockwise.)

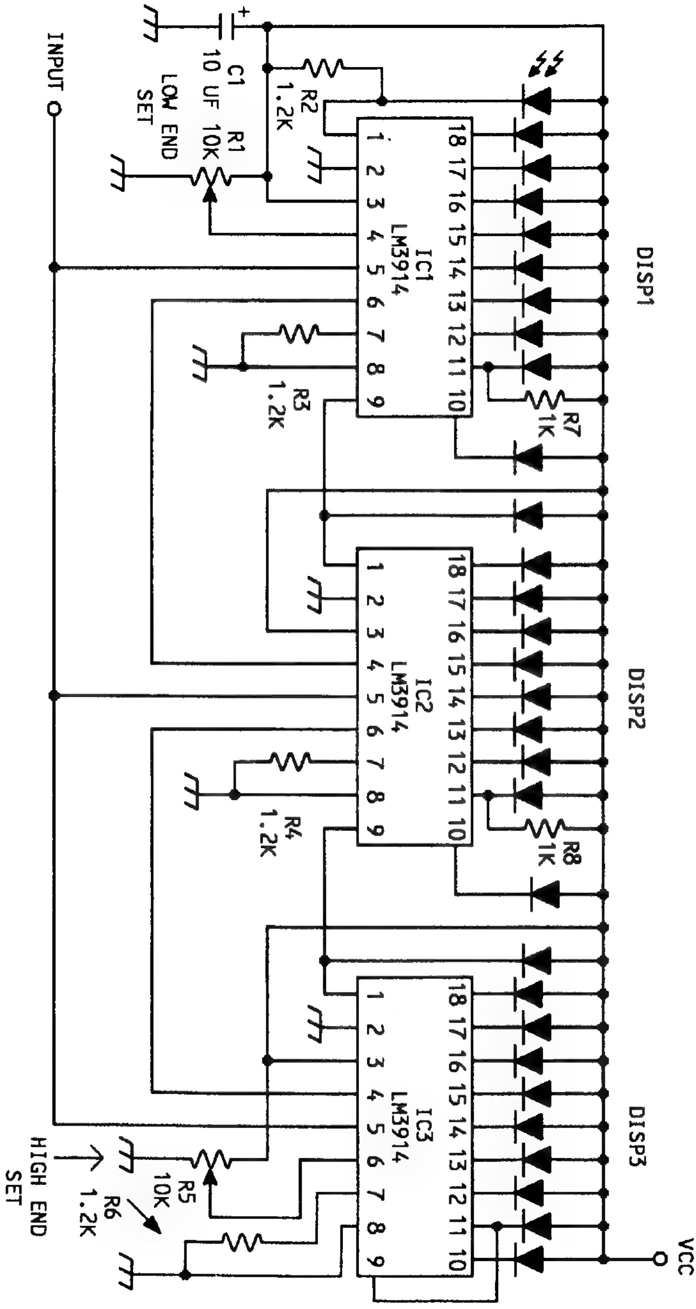
17. Adjust R2 on the E-DIAL PC board so the right-most LED just lights.

This completes the assembly and alignment of the E-DIAL. If you're planning to add the dial to a NorCal 38 Special, a good place to pick off the 8-volt regulated supply voltage is just to the right of VR1. There is a pad on the 38 Special board marked C20. This pad is ground. Directly below this pad is another pad (immediately to the right of C41) which supplies 8-volts.

Enjoy, 72, Bill, KD7S







KD7S E-Dial Schematic

The SST: A Simple Superhet Transceiver For 40 Through 20 Meters

by Wayne A. Burdick, N6KR
1432 Sixth Ave.
Belmont, CA 94002

Many NorCal members built the 40-9er, a 40-meter rig that ran pretty well on a 9-volt battery. The 40-9er was a ridiculously simple direct-conversion (D-C) transceiver that had its share of annoying traits, but did succeed in helping some first-time builders get started. Also—thanks to Doug Hendricks—the 40-9er brought together the Altoids Mints company and the Amateur Radio community, a marriage that seemed unlikely only a year ago.

After completing the 40-9er, I began work on a new superhet CW transceiver that I hoped would still have an extremely low parts count, but much better performance than the 40-9er. The result, the Simple Superhet Transceiver, is now on the air. The SST is available as a complete kit for either 40, 30, or 20 meters, and includes a custom enclosure, all controls, and a double-sided PC board. (See ordering details at the end of the article.)

While the accompanying schematic shows the 40-meter version, I have built SSTs for 30 and 20 meters with equally good results. Some component values for these bands are still in flux, so they'll be published in a subsequent issue of QRPp.

I like to think of the SST as a baby brother to the NorCal 40A. It clearly shares some DNA with the '40A, but it has almost 40% fewer parts! I also consider the SST my reinterpretation of a rig designed over twenty years ago: the Mountaineer (designed by Wes Hayward, W7ZOI). It was the first rig that I ever built, a 40-meter D-C transceiver intended for easy operation in the field.

Like that rig, the SST is truly pocket-size and trail-ready. It can be powered for several days from an internal 9V lithium battery, has excellent temperature stability due to the use of a VXO, and has provisions for an internal KC1 keyer/frequency counter. Unlike the Mountaineer and 40-9er, the SST has "real-rig" performance, and is a pleasure to operate.

The SST was originally to be released late in 1996. However, it turned out that Ori, AC6AN, had the 38-special up his sleeve, a very successful design that took all of Doug Hendricks's and Jim Cates's energy for several months. Since these two heroes of the QRP world were unable to take on the SST, Bob Dyer, KD6VIO (Wilderness Radio) has agreed to put together the kits for the NorCal/QRP-L field test.

Whatcha Mean, "Optimized?"

To put some numbers on it, the table below shows an approximate parts-count comparison of several well-known CW transceiver designs. (I didn't count connectors, the size and number of which vary widely.) With the exception of the 40-9er, all of the rigs listed are superhets.

Rig	# parts
NW8020	150
NN1G	150
NE4040	120
NorCal 40A	120
NorCal 40	112
38-Special	99
SST	77
40-9er	41

Clearly, this is a bit like comparing apples and oranges to pomegranates. But despite the SST's low parts count, it has performance beyond its place on the list. In addition, the SST is very easy to build. There are only four toroids, no toroidal transformers, and only two alignment steps.

SST features include:
* 1 to 3 watts out (varies w/band and supply voltage), adjustable down to zero
* fast, clean QSK with transmit monitoring
* 3-pole crystal filter at a low I.F. (about 4 MHz)
* built-in, no-adjustments AGC with received signal indicator LED
* stable VXO coverage of 10 to 20 kHz using varactor tuning (range varies w/ band)
* very low current drain—about 15mA
* stable operation from 10 to 16VDC, or internal 9V lithium battery
* works with the Wilderness KC1 keyer/ counter and BuzzNot noise blanker, both of which can be installed inside the SST
* all controls, connectors, and parts mount on a single 3.0" x 3.4" PC board
* 1.5"H x 3.2"W x 3.5"D custom enclosure (supplied unfinished)

Design Overview

The SST has essentially the same block diagram as the NorCal 40A, NE40-40, and similar rigs. However, it uses fewer parts for many of the blocks, with some minor tradeoffs in performance as a result.

Like these other rigs, the SST's receiver section an I.F. (intermediate frequency), but no I.F. amplifier. Since the receive mixer has considerable gain, I.F. gain is not really necessary. It turns out that you also don't really have to have an I.F. amplifier for attenuation. In the NorCal 40A, for example, I used two JFETs in a balanced, voltage-variable-resistance AGC circuit in lieu of an I.F. amp. In the case of the SST, the AGC circuit is much simpler; it works by reducing the bias on the NE602 product detector. A three-crystal I.F. filter provides quite respectable selectivity, thanks to the low I.F.

The transmitter has its own mixer and 4 MHz crystal oscillator. This means that what you hear when you key the rig is the actual transmitted signal, not a sidetone oscillator. By listening to received signals at this same pitch, you're guaranteed to be very close to their frequency when you call them. The usual buffer and driver stages have been replaced by a fast op-amp, but the final amplifier stage is conventional.

A varactor-tuned VXO rounds out the major functional blocks. On each band, the VXO crystal is an off-the-shelf frequency available from Digikey, as are the I.F. crystals. For example, on 40 meters, the VXO runs at 11.046MHz, and the I.F. is at 4.000MHz. This allows tuning from about 7.032 to 7.042 with an MVAM108 varactor diode, or 7.038 to 7.046 with an MV209. Both varactors are supplied with the kit.

On the other bands, the I.F. and VXO use other standard crystal frequencies. On 30 meters, an I.F. of 4.194MHz and a VXO crystal at 14.318MHz yields an operating range of about 10.105 to 10.120. On 20 meters, an I.F. of 3.932MHz is used. With an 18.000MHz VXO crystal, this translates to coverage of 14.046 to 14.064MHz.

We haven't left out the novice and tech-plus gang, either. The 40m/novice version of the SST uses the 11.046MHz VXO with the 3.932MHz I.F. to cover about 7.105 to 7.110.

I'm still amazed that Digikey has combinations of VXO/IF crystals that work out perfectly for all three bands, AND the 40m novice segment! While there are other combinations, too, these four are ideal because they cover the QRP frequencies while offering a low I.F. The resulting filter bandwidth is around 300 to 400Hz, and opposite sideband rejection can be well over 40dB. To get the same performance with an I.F. of 8MHz would take four to five low-cost crystals, and at 12MHz you might need six or more. Blow-by (signal leakage around the filter) is also harder to control with a high-frequency discrete-crystal filter.

Since the SST is a single conversion rig, when receiving at 7.040Mhz the math is: 11.040 (VXO) - 7.040 (RF) = 4.000 (IF). On transmit the rig subtracts the transmit oscillator from the VXO to get to 40 meters: 11.040 - 4.000 = 7.040.

Receiver Circuit Highlights

Please refer to the schematic (centerfold). Starting in the upper left-hand corner, you'll notice that the receiver input filter has only one tuned circuit—C1/RFC1. Since the SST's VXO runs at a high frequency, the single tuned circuit does a reasonable job rejecting the image. C1 resonates with RFC1 at the operating frequency while simultaneously providing an acceptable match to the low-pass filter (lower right-hand corner). C2 provides a match to the hi-Z input of U1. R1 is the RF gain control; it attenuates the signal that appears between U1 pins 1 and 2. Since this is a hi-Z point, the PCB traces to R1 must be very short.

C3's function is pretty clear: it puts pin 2 of the NE602 at AC ground, which is necessary since the input signal to U1 is single-ended, not differential. But what about D1 and D2? A little background will help.

Since the SST uses transmit monitoring at the I.F. rather than sidetone, I had to find a way to completely kill any RF signal coming in from U1 on transmit. Otherwise, the monitor tone would be too loud and would vary with power output. But smooth transmit monitoring is not as easy as it may seem: you have to protect both the receiver and transmitter on key-down, while muting the receiver and attenuating the input signal. It's a tall order.

Here's how it works in the SST. Switching diode D1 and PIN diode D2 are both reverse-biased during receive, so neither has an effect an effect on the received signal. As soon as the rig is keyed, D1's cathode is pulled down to ground, which causes three things to happen: (1) the positive half-cycles from the final amp output are shunted to ground, making C1 appear as part of the low-pass filter and effectively removing RFC1 from the circuit; (2) the DC bias on pin 2 of U1 goes well below 1.4V, unbalancing the mixer and cutting off the received signal; (3) D2 becomes forward biased, removing any remnant of the transmit signal seen on pin 1 of U1. Whew! The net result is very fast QSK using only two transmit/receive switching components (D1/D2).

Next we get to what is perhaps the strangest use of an LED that you'll ever encounter. D3, an ordinary red LED, is almost the entire fixed-calibration AGC circuit. The AGC circuit activates slightly on transmit, too, eliminating the need for a muting circuit between the product detector and the AF amp.

Stick with me, folks—this is really interesting. Product detector U2 normally has a 1.2 to 1.4VDC bias on pins 1 and 2; this is set by an internal voltage divider in the NE602. Like most standard red LEDs, D3 requires about 1.7 volts across it to become forward biased. With no signal at the AF output, D3's cathode is at zero volts, so it is reverse-biased and has no effect on the product detector.

But at an AF output level of around 0.6Vp-p, D3 starts to conduct on the negative half-cycles of audio. D3 is visible through a hole on the front panel, so as it conducts you can observe it charging up AGC filter capacitor C39. I could have used three silicon diodes instead of an LED to get over the 1.4V forward-bias threshold, but why not use a single part that doubles as a received-signal indicator? (Note that a "high-efficiency red" LED has a higher forward-bias voltage, typically over 2 volts. You could use this kind of LED if you wanted to increase the AGC threshold.)

D3's brightness is directly proportional to the instantaneous change in signal strength—not the absolute signal

strength—so it doesn't really function like an S-meter. Still, you can easily tell a strong signal from a weak one, and as Bob Dyer told me, with practice you can visually copy strong signals just by watching the LED!

Unlike most AGC circuits, there's no high-impedance buffer amp in the SST, so C39 has to be very large in value to both remove the rectified audio signal from the LED and set the AGC time-constant. But C39 is still physically small because its voltage rating can be very low.

The only other component involved in the AGC circuit is RFC2. It has a very low DC resistance, which holds pin 1 at the same DC voltage as pin 2, thus keeping the mixer balanced. This reduces distortion on strong signals and greatly extends the AGC range.

Some of you may be wondering what happens to an audio signal when you use the NE602 as an AGC-controlled product detector. As it turns out, by the time the signal gets large enough to cause distortion, the '602 is already in compression (i.e., hitting its limit). At the same time, the bias voltage on pins 1 and 2 is pulled down to as low as 0.6V when signals are very strong, so the NE602's input stage is nearly cut off. Distortion is nearly imperceptible under these circumstances. I haven't measured the AGC range, but I haven't yet encountered a signal it couldn't handle. Even if this happened you could turn down the RF gain (R1). The RF gain control is well isolated from C1/RFC1 by C2, so it has little effect on the Q of this filter.

In actual use, there is bit of a "thump" the first time C39 charges up, as with most AF-derived AGC circuits. Still, overall AGC action is quite good considering the simplicity of the circuit. In fact I'm now using it as a secondary AGC loop for the NorCal 40A, extending that rig's AGC range.

VXO and Transmitter Circuits

Since the receive mixer (U1) becomes unbalanced during transmit, I could not use U1's built-in oscillator as the VXO. A transmit signal tends to upset the NE602's built-in oscillator when the '602 is also being used as the receive mixer, and this can cause instability or chirp. Here, Q1 is the VXO, which is varactor tuned as in the 38-special. As Ori pointed out, RFC3 must be low-Q for best range; the value of RFC3 is also fairly critical.

The schematic shows an MVAM108 varactor at D4, which provides an operating range of about 7.032 to 7.042Mhz. However, you can add an SPDT switch to select either an MVAM108 or an MV209. The MV209 will provide a range of about 7.038 to 7.046MHz. I'm still experimenting with other varactors to see which single varactor will provide the best range. R7 sets the VXO output level, and is selected to provide around 0.6 to 0.8Vp-p at pin 6 of U1.

In most of my other designs, including the NorCal 40A and Sierra, I've used a JFET buffer and 2N2222A driver. I wanted to try something different this time. The LT1252, U5, is an inexpensive video amplifier IC, with nearly flat frequency response up to 50MHz in low-gain configurations. With its high input impedance and low output impedance it is perfect for this application, replacing the JFET, the 2N2222A, and the driver-to-final transformer, too. Its output impedance is under 10 ohms. R10/R11 form a gain-setting divider, just as in an op-amp. For example, if you need to increase the gain, you can decrease the size of R10. Be careful not to increase the gain too much, as this can cause instability and distortion. The LT1252 can swing about 8V peak-to-peak when running on 12V.

I eliminated the usual PNP keying transistor, instead simply keyingthe ground pins of the transmit mixer and the video amp. The slow start-up of the trans-

mit mixer oscillator makes for a clean rising edge, and if you want a slow fall time as well you can add an electrolytic cap in parallel with C23. Even without a slow fall time, the keying sounds quite good. Not a hint of chirp.

The final itself can be any of the usual suspects, including a 2N3553 or 2SC799 (or even a 2N4427 if you keep power under 2W). R12 does triple duty as the load for the LT1252, protection for Q2 on negative half-cycles, and the drive level control.

Construction

A very high-quality, double-sided, silk-screened and plated-through PC board is supplied with the SST kit. However, there's no reason why you couldn't build it using dead-bug, sickly-starfish, scraggly-cacti or other "ugly" techniques. Just remember to keep all RF signal leads short, and use good grounding, especially around the crystal filter and the video amplifier chip.

Some builders may want to try using a variable capacitor—rather than the varactor circuit shown—to increase VXO range. Just remember to ground the tuning capacitor well and keep all leads short. If you modify the VXO circuit in any way, check the output voltage of the VXO using a DMM (digital multimeter) and an RF probe. The voltage at the source lead of Q1 should be about 500 mV (rms).

I have not included RIT in the SST because it didn't fit my "ultra-compact, no-frills" definition. That said, it should be fairly easy to add. You'll need an LM393 dual comparator, an RIT on/off switch, an RIT pot, and two resistors. I'm leaving this one to QRPp readers as a design exercise, with one hint: look at the NorCal 40A or Sierra schematic!

There are provisions for a keyer and frequency counter; the relevant connection points are all labeled on the schematic. For example, note the "K" label near the key jack, J3. This is where you'd connect a keyer's keyline. Other points include "8V" (8 volts), "V+" (DC input), "A" (for the KC1 audio signal), "counter" (for the freq. counter), and "GND."

The SST will also work with the BuzzNot noiseblanker (Wilderness). I built one into the 20-meter version, and it killed all of the annoying impulse noise from my nearby power poles. The BuzzNot is so small (about 0.6 x 1.1") that it can nestle down directly on top of the receive mixer. The input to the BuzzNot should come from the anode of D1, and the output of the BuzzNot must be connected through a .01uF capacitor to the point marked "B" on the schematic. You can use a miniature potentiometer as a noiseblanker gain control as described in the BuzzNot manual. I used a SPDT switch instead, with one position connecting the full 12V supply to the noiseblanker, and the other placing a 2.2K resistor in series. I recommend at least two positions to give you some flexibility in different noise situations.

The custom enclosure's front and rear panels are secured to the PC board using the control nuts on the headphone jack, VFO pot, key jack, and antenna jack. PEM nuts are provided on these panels so that the top and bottom covers can each be secured using four 4-40 screws.

9 Volt Battery Option

Running a miniature transceiver from an internal, ultra-light, 9V lithium battery gives you an amazing sense of freedom. These batteries, available from many vendors, have over 1 Amp-hour of life, which translates to several days of casual backpack operation at 1/2 to 1 watt output. It's the ultimate for lightweight back-packing or the Spartan Sprint.

To use an internal 9V battery:

1. Replace the 8V regulator (LM78L08) with a 6V or 6.2V regulator. A low-dropout regulator is recommended.
2. Since the regulated voltage will be re-

duced, the varactor tuning range will decrease somewhat. You may want to use the MV209 rather than the MVAM108 to keep the upper portion of the tuning range, which usually is closer to the QRP frequency.

3. Adjust the transmit power level so that the maximum current drain on transmit is 100 to 120mA (or less), the recommended maximum for a 9V lithium battery. You can use other 9V battery types, but you'll need to adjust the power level for the desired battery life.

4. If you use a KC1, you must power it directly from the 9V battery, not the regulated supply, since 6V is too low for proper operation of the KC1's own 5V regulator.

Tune-up

This may be the world's easiest-to-align superhet. First, connect a suitable antenna and peak C1 on receive. Then plug in a hand key and peak C28 on transmit, preferably into a 50ohm dummy load. You can use a wattmeter, SWR bridge, or a DMM and RF probe as a signal indicator. The drive level control, R12, should be set for the desired power level.

You can slightly alter the value of C24 if you want to change the TX offset pitch. The pitch is usually around 650Hz with the indicated value of C24. Also note that the TX monitor tone will change if you alter the BFO frequency, which is controlled by C10.

Operation

You must use stereo headphones with the SST, or a stereo-to-mono adapter. For best results, use light-weight but efficient stereo headphones, such as Sony model MDR-W08. These phones have relatively poor bass response, which is easier on the ears over time. They also fold up and stow easily. The AF amp will drive a speaker, but only to moderate volume, since the peak voltage is limited by the AGC circuit.

NOTE: The headphone jack is on the FRONT panel on the SST, not on the rear panel! Don't plug your headphones into the key jack, which is on the back.

The RF gain control (R1) is mounted on the rear panel of the SST because it is rarely used. It should only be turned down when necessary to prevent mixer overload by gargantuan signals. Normally R1 is left all the way up (clockwise, viewed from the rear panel), and the audio level is controlled using R3, at the AF amp output. The AGC circuit does the rest.

The VXO control covers about 10 to 20 kHz with any particular varactor diode. This may not seem like much range, but you'll find that most QRP activity happens in the covered ranges, providing plenty of QSOs. You can add a switch and a second varactor to increase range if desired.

Conclusion

For an unknown reason, I set my sights years ago on small, efficient radio design, and it has been an interesting path to follow. But for every rig that has been successful, there is one no one will ever see, one that has in some way been a personal learning experience for me. For example, I built a hand-held NorCal 40A w/KC1 called the "Koala" which convinced me that you really CAN make a rig too small!

The SST is in some ways the end of a particular branch of the path. It began in 1993 with our first club project, the NorCal 40. Ever since I have wondered whether certain portions of that design—such as the AGC and muting circuits—could be reduced in complexity. I also wanted a truly compact superhet that would fit in a fanny pack pocket and still leave room for a wire antenna, headphones, and key.

The SST fulfilled both of these goals for me, and is much more stable and buildable than the experimental Koala. I hope builders find it an easy kit to build and operate, and I welcome your sugges-

tions for improvement.

SST KIT INFORMATION

The SST will be supplied only as a complete kit. It includes a high-quality double-sided and silk-screened PC board; a custom, unfinished .050 aluminum enclosure with hardware; all controls, connectors, knobs, rubber feet, etc.; detailed manual; and all parts for the band(s) of your choice. Painting and silk-screening are up to you.

The club price for each SST is $69. TO GET THIS PRICE, orders must be received by May 1st, 1997. After May 1st, the SST will be available as a Wilderness Radio kit for $85. I will be updating the design at that time based on results from the field test. The target shipping date is late May.

ORDERING INSTRUCTIONS

PLEASE DO NOT CALL DOUG HENDRICKS or JIM CATES. Hard as this may be to believe, they are NOT doing the kits! If you have questions, call Bob Dyer at (415) 494-3806 (9AM to 6PM Pacific time, M-F). Or, send e-mail to my HOME e-mail address only, which is svecbrdk@well.com.

1. Please enclose $69 per kit ordered before May 1st, and $85 thereafter.
2. For each kit ordered, you must specify the band: 40m, 40m/novice, 30m, or 20m. (Remember, this is a VXO-based transceiver, so the rig does not cover the entire CW band. Approximate coverage is: 40m, 7.032-7.042; 40m/novice: 7.105 - 7.115; 30m, 10.105-10.120; 20m, 14.046-14.064. Other ranges are possible with small modifications.)
3. California residents must add 7.75% sales tax PER KIT.
4. Shipping charges are extra: $3 U.S., $5 Canada/Mexico, $15 DX (other). This is a PER-KIT shipping charge.
5. Please make out checks to Wilderness Radio, NOT NORCAL. Wilderness will also need your name, call, address, phone number, and (optional) e-mail address with your order.
6. Send U.S. funds only (checks drawn on US banks, or an international money order) to:

    Wilderness Radio,
    P.O. Box 734
    Los Altos, California 94023-0734,
    USA

SST/40M PARTS LIST

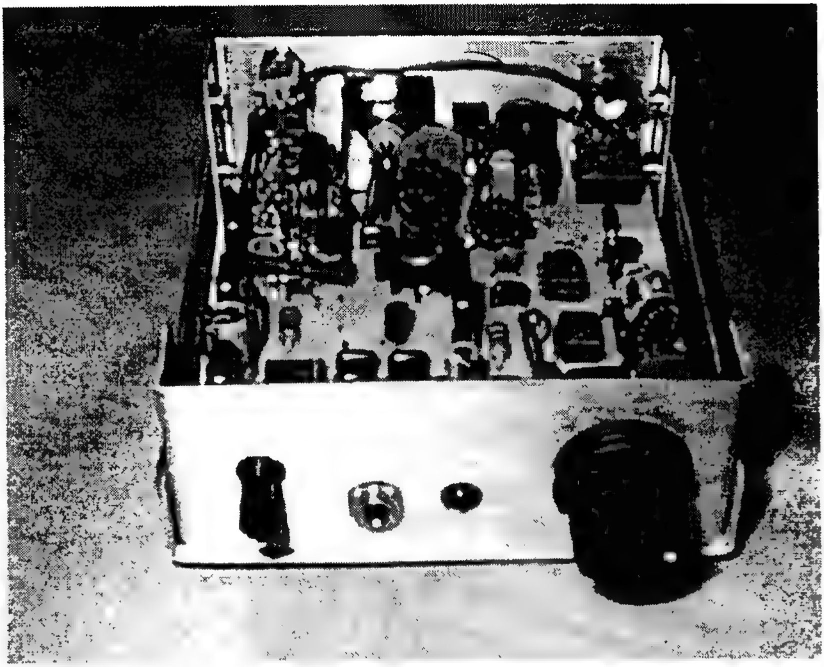
N6KR

Rev. A. (Preliminary)

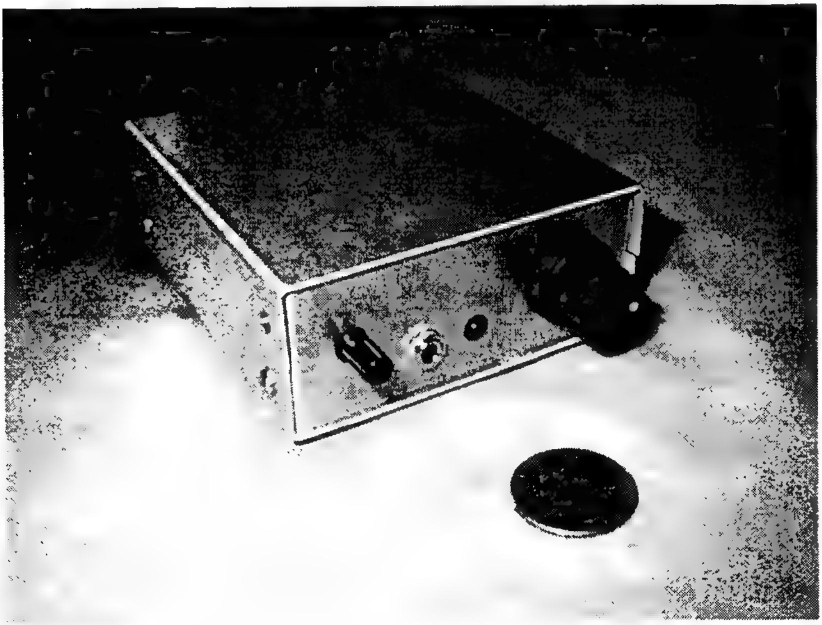
Note: All disc caps have 0.2" lead spacing

C21	1pF, 5% NPO disc
C2,C26,C29	5pF, 5% NPO disc
C10,C24	33pF, 5% NPO disc
C4	47pF, 5% NPO disc
C6,C9,C19,C20	82pF, 5% NPO disc
C27	100pF, 5% NPO disc
C7,C8	180pF, 5% NPO disc
C11,C25	270pF, 5% NPO disc
C34,C36	330pF, 5% NPO disc
C30,C35	820pF, 5% NPO disc
C3,C5,C16,C22,C38	.01¦F, 20% disc, Digikey #P4437-ND
C14,C23,C31,C32,C33,C37	.022¦F, 20% disc, Digikey #P4439-ND
C12,C13	0.1¦F, 5% film, Digikey #P4525-ND

C15	2.2uF, 25V elec, Mouser #140-XRL25V2.2
C17,C18	100uF, 25V elec, Mouser #140-XRL25V100
C39	470uF, 10V elec, Mouser #140-XRL10V470
C1,C28	8-50pF trim, Mouser #242-8050
D1	1N4148
D2	PIN diode, MPN3700
D3	Red LED, R.A. mount, Mouser #512-MV60539.MP7
D4	MVAM108
D4 Alternate	MV209 (see text)
D5	Shottky diode, Digikey #1N5817GICT-ND
D6	1N4755 (43V zener)
J1	DC barrel, Mouser #16PJ031
J2	BNC, PC mount, Mouser #177-3138
J3,J4	Jack, 1/8" stereo
L1	3.2uH, 28t #28, T37-2
L2,L3	0.6uH, 12T #26, T37-2
Q1	J309
Q2	2SC799 (alt: 2N3553, 2N4427)
R10	220 ohm, 1/8 watt
R7	330 ohm, 1/8 watt
R11	620 ohm, 1/8 watt
R2	1.8K, 1/8 watt
R8,R9	10K, 1/8 watt
R5,R6	100K, 1/8 watt
R12	100 ohm trimmer (P/N TBD)
R3	1K right angle trim w/shaft, Mouser #317-2091-1K
R4	10K panel mount, Mouser #31CW401
R1	50K right angle trim w/shaft, Mouser #317-2091-50K
RFC1,RFC3	15uH, Mouser #43LS155
RFC4	22uH, Mouser #43LS225
RFC2	1mH, Mouser #43LS103
RFC5	10 turns #26 on FT37-43 toroid (black)
S1	SPDT slide switch, Mouser #102-1271
U1,U2,U4	NE602 mixer/oscillator IC
U3	LM386N-1
U5	LT1252CN8-ND, Digikey
U6	78L08
X1,X2,X3,X4,X5	Xtal, 4.000MHz, matched, Digikey #CTX006-ND
X6	Xtal, 11.046MHz, Digikey #X025-ND
MISC.	Cabinet
MISC.	PC Board, double-sided, plated through
MISC.	Knob, 0.5" dia, Mouser #450-2034
MISC.	Knob, 0.6" dia, Mouser #450-2035
MISC.	Rubber foot, Mouser #517-SJ-5012BK
MISC.	Heatsink, star, 0.75" diameter
MISC.	3/8" x 4-40 Panhead phillips machine screw
MISC.	Manual
MISC.	Mating conn. for J1, Mouser #1710-2131



Interior View of the SST



Exterior View of the SST

A Good 'n Cheap QRP Dummy Load

by Dave Fifield, KQ6FR
fifield@pacbell.net

When you've finished building your 38 Special kit and added the 5 Watt mod, you're going to want to test it and tune it up on a reliable 50 Ohm dummy load that'll handle the 5 Watts easily. What if you don't have such a dummy load? There's no need to shell out lots of money for a professional load. You can make your own QRP dummy load very simply and inexpensively, and that has outstanding performance too!

A dummy load is an essential piece of test equipment for the amateur experimenter - no self-respecting radio ham should be without one. I present for you here a simple, low cost design that takes only about an hour to build (once you have collected the parts), and that you will use time and time again, wondering how you ever used to manage without it. This construction technique is not mine originally, somewhere in my past an elmer told me about it - I'm sorry, I can't remember who it was, so I can't credit him!

For the QRP dummy load you'll need the following parts:

Qty.	Description
32	100 Ohm, 0.25 Watt or 0.5 Watt, or better standard non-wirewound resistors
1	50 Ohm BNC socket - high quality recommended
1	Wood Patch or filler tin with lid (2.5 inches diameter, 2.25 inches tall cylindrical, tin plated steel)
1	Cup of mineral oil (4 fluid ounces)

Resistors

If you want to make a load that will dissipate 16 Watts without using mineral oil as a coolant you will need to use 0.5 Watt resistors. However, since the maximum QRP power allowed is 10 Watts for SSB and 5 Watts for CW, the cheaper and more readily available 0.25 Watt resistors should suffice. If you want a load that will dissipate 10 Watts continuously, you will need to fill the load with mineral oil if you use 0.25 Watt resistors. A load built with 0.25 Watt resistors will have a continuous rating of 8 Watts without mineral oil, so intermittent operation at 10 Watts should be fine. The choice is yours.

RF Connector

If you are going to use oil coolant, you'll need to use a connector that is leak-proof! Some BNCs are better than others. Try to get one with a good quality, close fitting Teflon insulator and silver plated center connector. Either a round flange model with a nut to tighten it in place or a square flange model that you can solder to the tin would be fine. I prefer to use the square flange models myself - I break the four corner pins off and mount the socket flat onto the tin, soldering it all the way round.

Tin

You remember that old tin of Wood Patch that you bought from the hardware store ages ago for all those honeydew projects? It's probably languishing at the back of a pile of old paint tins in your garage. The best you can hope for is that it's all dried up and useless, in which case you can just empty it out and use the tin. The worst thing that could happen is that it is still usable and "your better half" finds out what you're doing and insists that you use it to do the jobs round the house before you can have the tin! Either the 0.25 Watt or 0.5 Watt resistor version should fit in this type of tin.

Mineral Oil

You can get mineral oil from your

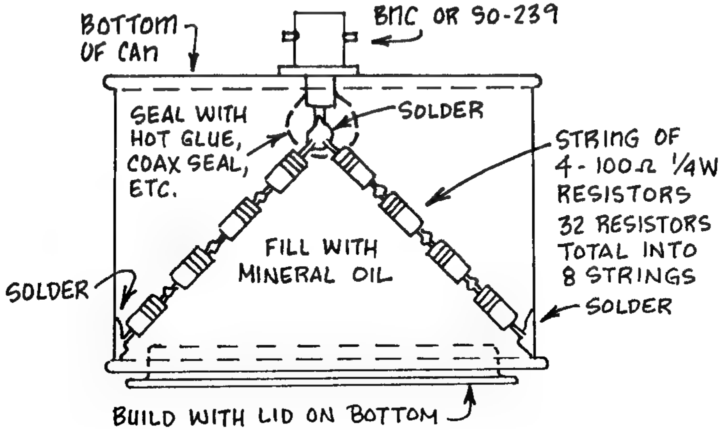
local drugstore. You'll need about 4 fluid ounces to fill the tin.

Construction

The load is constructed using eight strings of resistors wired in a cone shape, each string consisting of four 100 Ohm resistors in series. The eight strings of resistors are wired in parallel (forming the 50 Ohm required load). They are mounted in the form of a cone from the center connection of the BNC socket. Mount the BNC socket in the center of the bottom of the tin (not on the removable lid).

It's easiest to construct the strings of resistors vertically on a scrap of copper clad PCB. Start by soldering one resistor to the PCB using the full length of the component lead. Then snip the top (unsoldered) lead off to leave only about 1/8th inch lead remaining. Snip the leads off two more resistors to 1/8th inch from the resistor body, then solder these in series vertically onto the resistor already on the scrap of PCB. The fourth (top) resistor in the string should only have one of its leads snipped off to 1/8th inch - leave the other lead full length. Solder the short end to the vertical string of 3 resistors on the scrap PCB. Unsolder the resistor string from the board. This completes one string. You need to repeat this whole operation seven more times so that you have eight strings in total.

Hold the eight resistor strings "in parallel" in one hand then twist one end of the resistor string's leads tightly together (see photo 1). Solder the twisted ends together and trim off the excess lead length (you'll need a fairly strong pair of cutters to do this). Solder the trimmed end to the center pin of the RF connector inside the tin. Be careful not to let solder run and short the center connection to ground (like I did on my first attempt!). You'll find that because of lack of space to maneuver the soldering iron around inside the tin, this is a fairly tricky operation. Try holding the resistors with pliers to make more room for soldering.



Drawing of Interior of Dummy Load

The resistors may end up being soldered off to one side of the center pin, so they may not be perfectly centered in the tin - this is not a problem.

The other end of each of the strings should then be spread out, trimmed to the minimum length necessary to reach the side and then soldered to the inside perimeter of the tin (thus, the cone shape - see photo 2). Keep the wire ends as short as possible. This results in a load that has minimal inductance (if you keep the strings as short as possible) and minimal capacitance (the self-capacitance of each string is one fourth of the self-capacitance of one resistor).

The cone shape keeps the resistors apart which further minimizes inductance and capacitance effects, and allows better heat distribution in the oil. Speaking of the oil, once you have tested the load with your Ohmmeter (it should read 50 Ohms across the BNC connections) you can fill the tin with oil and seal it. If using oil, it would be best to seal the tin permanently by soldering the lid in place - you don't want any mess ever. Just don't forget to leave about 1/4" of space at the top of the oil for expansion!!

Performance

I constructed the prototype using cheap 0.25 Watt carbon film resistors. I put it on a 30KHz to 6GHz network analyzer at work to see how it performed. I measured it from 30KHz to 500MHz. Quite frankly I was amazed. Up to 50MHz it offers a VSWR of less than 1.05:1!! Above 50MHz the VSWR rises to 1.1:1 at 100MHz, 1.2:1 at 200MHz and 1.5:1 at 500MHz. The load is very slightly inductive (about 7nH - which is what I expected) - this will only affect the VSWR significantly at VHF/UHF, which agrees with the lab measurements. These numbers mean that it is almost a perfect dummy load for our QRP operations from 1.8 to 30MHz.

The prototype happily dissipated 5 Watts continuously without oil and 10 Watts continuously with oil.

Materials needed to build the KF6QR Dummy Load

KQ6FR Dummy Load

Conclusions

You can make a GOOD 'N CHEAP QRP dummy load for around $5 (depends what you already have in your junk box). It performs very well and should be a reliable piece of test equipment for years to come.

For those who also (occasionally) run QRO, there's no reason you shouldn't scale everything up to make a 100 Watt (+) load using higher wattage (2 Watt?) resistors in a larger tin.

72, Dave, KQ6FR

The W6MMA SLV Portable Antenna

by Vern Wright, W6MMA
1606 Pheasant Way
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Phone: 916-622-2390After 6PM PST

Antennas have always fascinated me, and I spend a lot of my time experimenting with various antennas. My current antenna system is highlighted by a 4 Square Vertical Array on 75, a 6 element triband quad on a 72 foot boom at 72 feet, a 40 meter dipole, and the W6MMA SLV. What is the W6MMA SLV? It is my version of the St. Louis Vertical antenna that was first printed in the Sept. issue of QRPp and the August issue of "The Peanute Whistle". Dave Gauding's original design involved using 300 ohm twin lead to wind a baseloaded coil, and then extending

the antenna with a piece of wire 16 feet long.

The unique thing about the SLV was the use of the Southbend SD20 telescoping pole to support the antenna. It was lightweight, cheap, and strong. The best thing about it was the portability of the antenna. But I was not satisfied when I tried my SLV. It has been my experience that center loaded verticals make much better antennas than do base loaded verticals. So I decided to do some experimenting.

I have a "screwdriver" mobile antenna that was invented by Don Johnson, or he invented the portable screwdriver method of adjusting the antenna. This antenna mounted on the front of my pickup has enabled me to work lots of DX during my daily 40 minute commute to and from work. I was driving to work one day, thinking about the SLV, and just happend to look at the "screwdriver" mounted on my front bumper. The lightbulbs went off in my mind. Why not use the "screwdriver" method of a variable coil to wind the coil on the SLV?

I thought about it all day, and that night came up with the following system. The coil would be wound on 1 1/2" schedule 40 pvc pipe that had "threads or grooves" cut into it by a lathe, just like the original screwdriver.. Then, I would make a shorting bar out of brass, and a "slider" with a thumbscrew adjustment to change the tap on the coil. It would be simple, and fast. With the picture in my mind, I set out to gather the materials.

This antenna would be an "all band" one, with the same coil and simple changes of radiators and radials all that was needed to change bands.

Vern Dawson is a friend of mine who is retired and has a lathe. He loves to experiment with the "screwdriver" antennas, and makes them commercially to sell. I had him build me a coil form out of schedule 40 PVC, winding the grooves at a pitch of 8 turns per inch. I had no idea what it would take so we started with a coil 18" long. When we finished, I put the coil over the SD20 fishing pole and it slid down to where it was about 5 feet above the ground. Next, I ran a piece of wire from the top of the coil to the top of the pole. Then, I ran a wire from the "slider shorting bar" to the base of the antenna. Here, I had a toroid that was exactly like the one from the "screwdriver antenna". I then connected the bottom wire of the antenna with the toroid. The radials were left as before, with the coax center conductor connected to the radiator and the radials connected to the shield.

The next step was to take my MFJ antenna analyser and see where the antenna was resonant. It was at about 1.95 MHz. Wow, that was much better than the stock version. Let's see how it hears.

When I hooked it up to the rig, signals were booming in on 75 meters. I had slid the slider up and resonated the antenna at 3.800. I then switched to the 4 Square, signals were a bit louder, but not by much. It was much better than the original SLV

that I tried. Signals that were S2 to S3 on the original SLV and were S9 on the 4 Square were S7 to S8 on the W6MMA SLV.

I couldn't wait to transmit. I like to build homebrew SSB radios, and two of my favorites are the Cascade and the Epiphyte 2, both of which put out about 5 watts. I hooked up the Epiphyte and gave Derry Spittle, VE7QK a call on our scheduled time and frequency. Derry came right back to me on the first call. I then explained that I wanted to do an antenna comparison test. I switched back and forth from my 4 Square and the W6MMA SLV. Derry gave me the following report, "The 4 Square is 1 or 2 S units better, but just barely. Vern, that thing works. What is it?"

When I explained what I was using, Derry could hardly believe it. But, did I really improve the antenna? Would the original SLV have worked as well? The next night, I repeated the experiment, but this time it was with a ham in Southern California. I had him listen to 3 antennas, the 4 Square, the W6MMA, and the stock SLV. He gave me the following reports:

4 Square- 5 and 9
W6MMA SLV - 57 to 58
SLV - 52 to 53

I have confirmed the above results many times, and have come to the conclusion that the SLV can be significantly improved by adding a center loaded coil and using it in the configuration shown.

I did some evaluation and more experimentation and have come up with the following version. The W6MMA uses a 1.5" piece of PVC that is 17" long, with a coil that is 14" long with grooves turned at 8 turns per inch. I then put a collar that is 1/2" wide on the top end, and another that is 1.5" wide on the bottom. The bottom has a bushing installed that has an inside diameter of 1 1/8". The brass slider is 1/4" square stock and is shimmed with a washer to give it the right height above the PVC to allow for room for the "Finger Stock" to move.

I did some more experimentation and found that I could eliminate the toroidial transformer and I also found it necessary to "beef-up" the bottom of the pole. The first step is to carefully remove the threaded portion by splitting it with a hack saw and then peeling it off. The pole will now fit into a base assembly. I start with a piece of 1-1/4" PVC pipe about 4 inches long. I mount two screws, one for connection to the antenna, the other for connecting the radials, and then I added a bnc connector for the coax feedline. The pipe fits into a 1-1/4 x 1-1/4 coupler that fits onto a 1-1/4" reducer that goes over the wooden dowel with a large spike to anchor it on the ground. See the drawings for details.

Operation

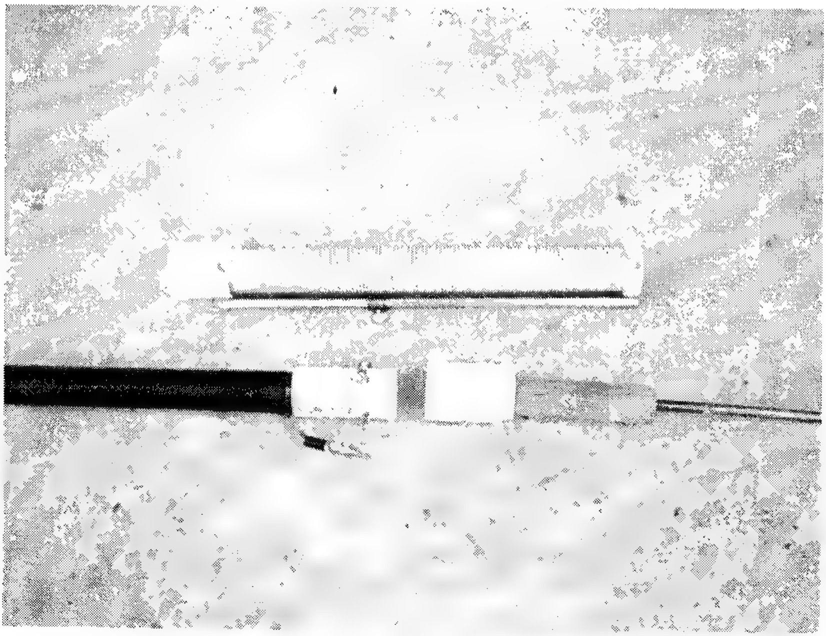
To set up the SLV, Vern's Version, place the dowel in the ground, then the modified fishing pole. Extend the first section out, and place the SLVVV coil on the pole. It should slide down to fit about 5 feet above the ground. Attach the radiator wire to the top eye of the pole, and extend

the sections out. Hook the bottom end of the radiator wire to the top of the coil, then attach the bottom of the coil to the base of the antenna as shown in the drawing. Extend your radials, which are cut about 1/4 wavelength for the band of interest, and then adjust the coil for lowest SWR using your SWR meter or MFJ 259. Then hook up your rig and you are on the air. The whole process takes about 5 minutes from start to finish. I have my coil marked for the various bands and it is a simple matter to return to the same place each time I operate.

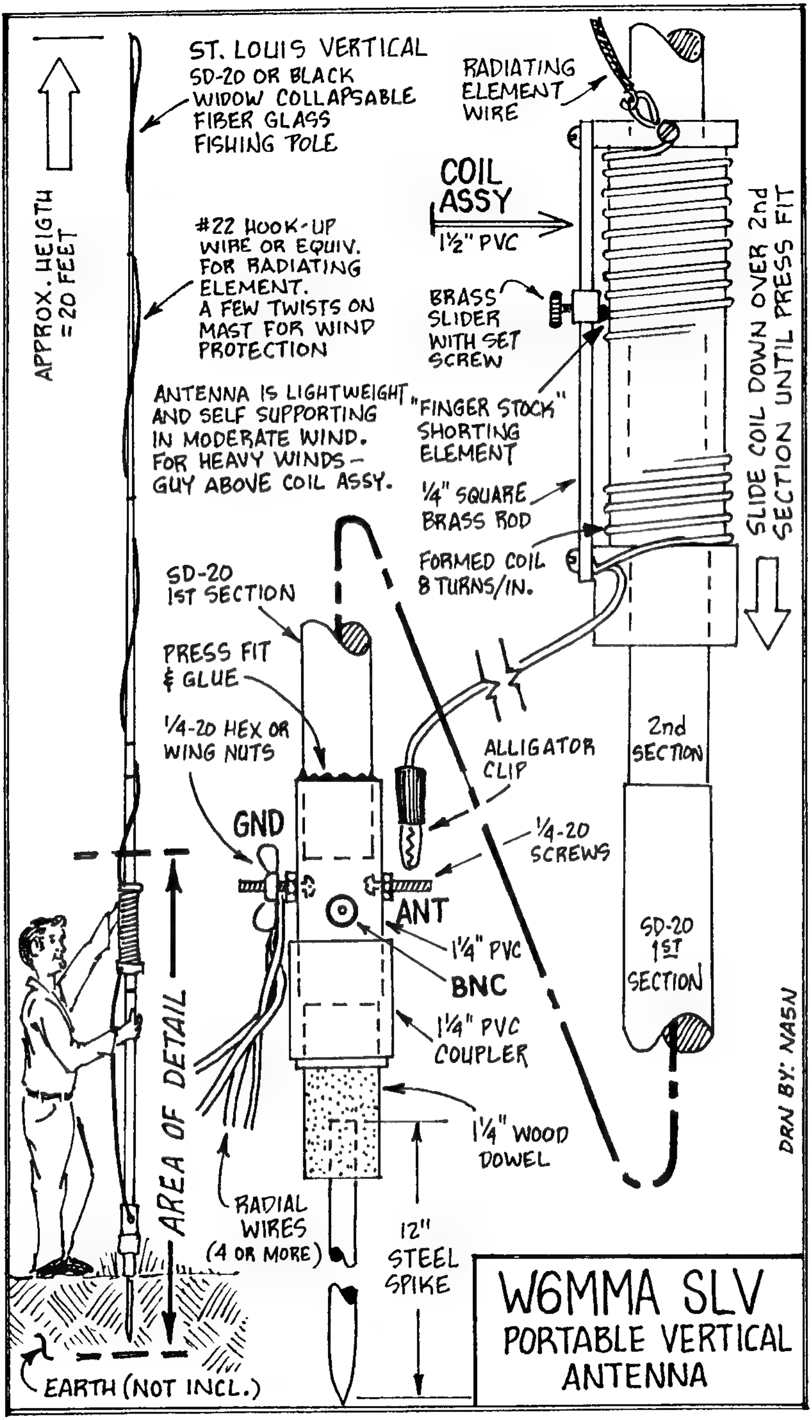
Construction

Paul Harden, NA5N has done some great drawings that show complete construction details. The big problem is the availability of a lathe to turn the coil. I have decided to make 2 types of coils available, the SLVVV 80 and the SLVVV 40. The SLVVV 80 will work 80-10 and the SLV 40 is a much smaller version designed for the back packers. It covers the 40 - 10 meter bands. To order the coils, send $50 plus $5 shipping and handling to Vern Wright, W6MMA. 1606 Pheasant Dr., Placerville, CA 99999. The SLVVV 40 is $40, plus $5 shipping and handling. The builder will have to supply their own pole, ground radials, bottom connector, and radiator wire. In other words, this is just the coil assembly. If you have questions, please call me at 913.622.2390 after 6PM California time.

Thanks to Paul Harden, NA5N, Vern Dawson, Doug Hendricks, Derry Spittle, and especially to Dave Gauding, NF0R, for coming up with the original SLV. 72, Vern



80-10 Coil Assembly for Vern's SLV



ST. LOUIS VERTICAL
SD-20 OR BLACK WIDOW COLLAPSABLE FIBER GLASS FISHING POLE
APPROX. HEIGTH = 20 FEET
#22 HOOK-UP WIRE OR EQUIV. FOR RADIATING ELEMENT. A FEW TWISTS ON MAST FOR WIND PROTECTION
ANTENNA IS LIGHTWEIGHT AND SELF SUPPORTING IN MODERATE WIND. FOR HEAVY WINDS - GUY ABOVE COIL ASSY.
RADIATING ELEMENT WIRE
COIL ASSY
1½" PVC
BRASS SLIDER WITH SET SCREW
"FINGER STOCK" SHORTING ELEMENT
1/4" SQUARE BRASS ROD
FORMED COIL 8 TURNS/IN.
SLIDE COIL DOWN OVER 2nd SECTION UNTIL PRESS FIT
SD-20 1ST SECTION
PRESS FIT & GLUE
1/4-20 HEX OR WING NUTS
GND
ALLIGATOR CLIP
1/4-20 SCREWS
ANT
1¼" PVC
BNC
1¼" PVC COUPLER
1¼" WOOD DOWEL
2nd SECTION
SD-20 1ST SECTION
AREA OF DETAIL
RADIAL WIRES (4 OR MORE)
12" STEEL SPIKE
EARTH (NOT INCL.)
DRN BY: NA5N
W6MMA SLV
PORTABLE VERTICAL ANTENNA

THE OL' KENWOOD STORIES

by Bob Tellefsen, N6WG
6607 Normandy Drive
Newark, CA 95460

As most every QRPer knows by now, we have had another great season of Fox Hunting. After each hunt, many hunters would post messages to the QRP List on the Internet, usually along the lines of "Great signal, Joe (or Jack or John or whoever was Fox). Glad I was able to work you.", or maybe "Gee, I listened for two solid hours to white noise, but never a hint of a Fox." Sure been there and done that, too.

The Ol' Kenwood stories started out as a little different way to say "I was there too, and maybe I did, or maybe I didn't, catch a Fox." The first one, for the Halloween hunt, was just knocked off as a tongue-in-cheek , long way to say "Nope, never heard the Fox." Turned out I had so much fun writing it, that the rest of the stories, while still serving as reports, were written for my own amusement. I hope you enjoy them, too.

THE GHOST FOX FROM THE GREEN MOUNTAINS

Now that you're all settled down around the fireplace with a warm drink in hand, let me tell you about the time I hunted the ghost fox from the Green Mountains of Vermont.

It was on Halloween Eve, back in '96, a cold, still night it was. My trusty old fox hound, Kenwood, and I went out that night to see if the ghost fox would come our way. I had my fox gun loaded with 5-watt shot, and old Kenwood was in good voice, just hoping to get a whiff of this ghostly fox.

We were out in the back fields where it was very still, and, unusual for a Halloween Eve, the QRN sprites were keeping quiet. Wonder if it had anything to do with those sunspot things we hear about. Anyway, I thought sure if the fox came around we would hear him this night.

From time to time, when the wind would blow from the east, faint in the distance we could hear the horns of other hunters, blowing their calls to entice the fox closer. From this, we knew he was out there, SOMEWHERE. A good fox hound will only call when he actually hears the fox, so we were pretty sure the critter was down off the mountains and prowling.

Then, from up north, I heard Larry, W1HUE/7, fire his fox gun. I could even hear his dog barking as he exchanged compliments with the fox. Couldn't hear the fox, though. Must be the way the wind was blowing at the time. I wonder if that was the only detour the fox made through our end of the world.

Never heard any of my nearer neighbors salute the fox, so I guess he pretty much stayed close to his native Green Mountains. Through the rest of the evening, sometimes when the wind would change, we could hear faint cries of other hounds calling the fox. But of the ghost fox of the Green Mountains himself, not a trace.

Finally, cold, tired and frustrated, old Kenwood and I headed back to the cabin. While he dozed in front of the fire, I helped the XYL buy off the howling mobs of witches, frogs and spacemen assaulting our cabin door, howling "Trick or Treat" in the night.

Anyway, that's how it happened the time I went hunting the ghost fox of the Green Mountains. Ghost Fox 1, me nothin'.

OL' KENWOOD AND THE DESERT FOX

Howdy, neighbor. Come on up on

the porch with the rest of us and set a bit. I was just fixing to tell my friends about the time ol' Kenwood led the posse after the Desert Fox.

Down in Tombstone, Arizona, the folks were kinda hard up for food raising. Desert isn't a great place for farming. Someone got the idea of bringing in some prairie chickens from the midwest and turning them loose to forage on the desert. Well, that worked, sort of. Desert isn't generous to them as live there. The prairie chickens held on ok, but were kinda scrawny. Took several to make a meal once you caught 'em. There were enough of them scrawny prairie chickens to feed the folks, but not much left over.

Then one day this unsavory Desert Fox character rides through town with a bunch of prairie chicken carcasses strapped to his saddle. Ticked off the townfolks there in Tombstone, since they had been figgerin' on catching and eating them birds themselves. They figgered this Desert Fox character had been poaching their prairie chickens.

The Desert Fox looked to be a tough customer, so the townfolks didn't think they wanted to take him on themselves. Someone came up with the idea, "Let's form a posse and go after him! There's strength in numbers if we got 'em." Well, they looked at each other, and said, "Who's gonna lead this here posse?" No-one volunteered.

Then my friend pipes up, "Who better to go after a Desert Fox than a fox hound, and I know a good 'un." Next thing you know, I'm getting this phone call, asking me to bring ol' Kenwood down to Tombstone to help catch this Desert Fox feller. So, I put it to ol' Kenwood to see what he thought of the idea. "Shucks," he said, "Why not?". So we loaded up my ol' station wagon and headed fer Tombstone.

When we got there, it was near dark, but ol' Kenwood wanted to get on with it. We put out the word fer all the fox hunters to gather at the north end of town, and we'd see what we had to work with. First thing we needed to find out was where was this Fox feller likely to be?

Well, it was just turning 0200 UTC by the Tombstone City Hall clock (Have you ever heard a clock beat out 0200 in code? Takes a while.) when we heard the Desert Fox off in the distance singin' somethin', sounded like "CQ CQ FOX de NQ7K". Funny kinda song, but hearin' it helped us figger out where he was at.

One ol' geezer said, "By the sound o' that, he must be out around milepost 7038 on Highway 40M, near as I can tell from here." So we made this plan up quick that we'd all head fer milepost 7038 and see if he really was there. Some of us would head down towards him from milepost 7040, and some up from milepost 7035. Figgered we'd find him camped somewhere along there. Sure enough, when we got out there, he was camped just a few hundred Hertz off milepost 7038. Ol' geezer had a darned good ear.

Well, now we found this Desert Fox feller, we figgered we better have some idea of what we were gonna do about him. Some were fer shootin' him, some were fer hangin' him, and some just wanted to run him off. Well, everyone finally calmed down, and we decided the best thing all around would be to ambush him, take back all the prairie chickens he'd poached, and run him out of town (Town limits were kinda wide and vague in Tombstone).

Ok, we got that settled. Meanwhile, old Desert Fox is still out there in his camp singin' "CQ CQ FOX de NQ7K". Funny how that tune gets to a feller. We thought maybe if we tried singin' his tune with him, we'd lull his suspicions and he'd be easier to capture. So, I had ol' Kenwood gave it a try, but it didn't come

out just like what the fox had been singin'. Best ol' Kenwood could do sounded like "NQ7K de N6WG, or somethin' like that. It worked though, 'cause he musta thought there was another Desert Fox type around and wanted to visit. He hollered back at ol' Kenwood "N6WG TNX 559 AZ MIKE NR 47". Well, I thought, what kinda singin' is that? Maybe if we imitate it we can lure him over here. So I had old Kenwood holler back, "QSL MIKE, UR 539 CA BOB NR 26." Darned if he didn't take the bait and wandered over to see who was singin' his song.

At that point, the posse jumped in trying to surround him.. Trouble was, in all the QRM from them horses, ropes, guns, dust and elbows, he just up and walked away from the fracas without anyone actually seein' him go. We did find his haul of prairie chickens, though, and took them back to Tombstone. The folks there were so grateful, they put on a big barbecue that night with all them scrawny chickens (Did I say it took a lot of them to feed a feller?), and ol' Kenwood ate his share. While we were eatin', though, we could still hear that ol' Desert Fox out there singin' his song in the desert night, "CQ CQ FOX de NQ7K". An' darned if he didn't keep it up 'til the town clock struck 0400. Guess he musta been kinda tired then, 'cause we didn't hear any more from him that night.

Next morning, ol' Kenwood and I loaded up the wagon and headed home. He was feelin' pretty good, havin' done his civic duty fer the good folks of Tombstone. An' that's how ol' Kenwood led the posse after the Desert Fox, down in old Tombstone. Thanks, Mike

OL' KENWOOD AND THE MISSOURI MULEFOX

So you want a story, huh, nephew? Well, boy, set down here by your ol' Uncle Bob and I'll tell you about the time ol' Kenwood and I caught us a Missouri mulefox.

No, no, I'm not making this up, there really is a mulefox. You've heard of muledeer, haven't you?. Of course there's a mulefox, and they live in Missouri, mostly. They're pretty big, as foxes go, and very strong fer their size, too. That's not why they're called mulefox, though. It's the long ears that help them hear real good, and a strange kind of braying yip that sounds more like a donkey than a fox. There aren't a lot of mulefoxes left, though. Don't see one very often.

No, no, I'm not making this up. Now just sit down and listen.

A mulefox's strength was kind of useful, back when more folks lived on farms. Used to be folks would catch a very young mulefox kit and raise him to be used to a harness. This was back when a real mule was a farmer's main plow puller. A mule cost a lot then, too. Well, sir, folks that could catch and raise a mulefox would teach it to pull a QRP plow just right for the family vegetable garden. So, while the farmer had his mule out plowin' his fields, the farmer's wife would plow up the family garden with the mulefox.

Lessee, where was I? You're getting me confused. Oh yes, that was the time ol' Kenwood and I were down in Missouri visiting relatives. We'd gone out in the fields fer a walk to give him some exercise, when we heard a sound we couldn't figger out. Sort of sounded like a dog and a donkey fighting. Well, with nothing better to do, we followed the sound to see what it was. I could hear RTTY birds singin' loud all around us, but this was somethin' I didn't recognize.

We left the road and cut through a small stand of trees to the edge of a small 40 meter field, and there in the middle of the field, sittin' and singin' his ol' song, was a real Missouri mulefox. Like I said, they aren't real common, so this was a treat to actually see one. Well, ol'

Kenwood thought this was a real treat, too, but of a different kind. He was lookin' to take a big chomp of mulefox, maybe see if they're good to eat.

He hunkers down in the grass and goes stalkin' after that mulefox. Remember I said they had big ears to help them hear real good? Well, Mother Nature played a trick on the mulefox, 'cause while he's singin' his raucus song, he can't hardly hear a thing. Pretty soon, ol' Kenwood is real close behind ol' mulefox, and then he jumps. Ol' Kenwood gets a good mouthful of mulefoxtail, and figures he's got ol' mulefox now.

No, boy, I'm not makin' this up. It all happened just like ol' Uncle Bob is tellin' you.

Like I said earlier, ol' mulefox is unusually strong fer his size, so Ol' Kenwood was in for a surprise. He started tuggin' on that mulefoxtail, figgerin' he'd bring it over to show me what a good hunter he was. Well, this got ol' mulefox's attention, I tell you. So ol' mulefox starts headin' fer the far side of the field, while ol' Kenwood is tryin' to head fer me.

Well, darned if ol' mulefox doesn't start pullin' ol' Kenwood around. Ol' Kenwood fights back, puttin' all four feet on the ground fer a good grip. But ol' mulefox just keeps apullin' and draggin' ol' Kenwood after him. Ol' Kenwood's getting mad now, so he really digs in with all four paws, and with ol' mulefox tuggin' him along, soon ol' Kenwood's paws are diggin' in and he's in dirt up to his shoulders. But, no sir, he's not givin' up, not ol' Kenwood.

Ol' mulefox pulls forward, and ol' Kenwood pulls back, but ol' mulefox just keeps goin' fer the trees across the field. The whole time this is goin' on, ol' mulefox keeps on singin' his loud song, yippin' or braying what sounds like "N6WG UR 559 MO DAVE NR 618". Must have gotten to ol' Kenwood, 'cause he finally opens his mouth so he can holler back. Well, of course when the mulefoxtail is loose, so's ol' mulefox. Anyway, ol' Kenwood's so mad, he just sits down and hollers right back at ol' mulefox, "W0CH UR 559 CA BOB NR 26", so there! An' ol' mulefox trots off into the far woods and disappears.

Ol' Kenwood gets up and starts back over to where I'm sittin, havin' a good laugh. You can see why the mulefox was a real help to the farmer's wife, 'cause goin' across the field there were two furrows where ol' Kenwood's paws had dug into the soil. Those furrows were as straight as if they had been plowed with a good Missouri mule.

Anyway, that's how ol' Kenwood and I found and wrestled with the ol' Missouri mulefox.

THE GIFT OF THE GOLDEN FOX

Ok, nephew. Crawl up here in Uncle Bob's lap, and we'll have a story. Oh, you want one about when ol' Kenwood and I were young, do you? Well, ok.

Let's see. I know, I'll tell you about the time ol' Kenwood and I dug for gold in the old Mother Lode goldfields out in California.

No. Yes. I mean, No, I'm not makin' this up. Yes, we really did dig for gold, ol' Kenwood and me.

There's a spot in the Sierra Mountains out there in California where a whole lot of gold has been dug up. You ever hear of the 49ers? No, not the football guys, these were gold miners. Miners dig in the earth to get stuff out, like gold. They came from all over the country to dig for gold in California.

Well, they dug up a lot of gold a long time ago, but there's still some around. They called that area the Mother Lode country, 'cause that was supposed to be where all the gold came from. They figgered if they just kept diggin' and

explorin' they'd find the Mother Lode and be rich.

Ol' Kenwood and I were travelin' through the area years ago, just to see what was out there. 'Course, ol' Kenwood was young Kenwood back then, just growin' out of bein' a puppy. Kind of a teenager dog, you might say. Big head, long legs, big feet and a clumsy tail. Well, it was nice country, up there in the Sierras, and the diggin' and pannin' fer gold looked interestin'. So we decided to stick around fer a bit and see if we could find some gold ourselves.

In some places gold was dug from tunnels into the mountains, some just came from holes in the ground, and some was dug out of stream beds. We found an old claim that had been abandoned, and figgered we could just dig around and see if anythin' turned up. We would dig during the morning and part of the afternoon. Kenwood was a big help, with those oversize feet he was still growin' into, and boy, could he throw dirt. Well, in the afternoon, we'd drag a bunch of loose dirt down to the stream and pan the rest of the day, trying to see if there was actually any gold in all that dirt we had dug.

Let me tell you, nephew. We dug a whole lot of dirt for mighty little gold. We were scratching out just enough scraps of gold to buy food, and that was it. Hard work, and no sign of gettin' rich. Reckon that's why that claim had been abandoned. Anyway, in the evening, we'd have a fire and I'd cook our food. While we were eating, sometimes miners from other claims would come by to visit a bit. It's hard work, and you need to visit with others at times just to relax and rest up.

One evening our visitor, a rather grizzled old miner who had been out in the goldfields since dirt was new, told us a story that I rather liked, about the Golden Fox of the Mother Lode.

I know you've seen pictures of foxes in your school books. Did you know that some kinds of foxes live in holes in the ground? Burrowin' foxes they're called. Anyway, this Golden Fox was supposed to be one of those.

According to the story, the Golden Fox likes to dig his burrow where the ground is rich in gold dust, that's little tiny pieces of gold but a lot of them. Guess it makes the dirt looser and easier to dig. If you could see him in the daylight, he would have kind of a golden shine to him, 'cause of all the little specks of gold caught in his fur.

Well, there aren't a lot of Golden Foxes up there in the Sierras, or anywhere else, either. You're more likely to hear one than ever see one. Sometimes, you can hear them singing at night, out there in the wilderness, particularly on very quiet nights. They don't have as loud a cry as some other foxes, so you really have to listen for them. Kind of a QRP fox.

Now, as the story goes, if you do hear a Golden Fox singin' in the night, you want to try to find him. You don't want to catch him, just find him. You see, while he's sittin' out there singin', he often has to scratch, 'cause those lil bits of gold get scratchy down in his fur. Kinda like hair clippin's after a haircut. You've seen a dog scratch, kickin' with his hind leg 'til he gets his itch scratched. Well, same thing with the Golden Fox.

Well, when ol' Golden Fox has had his evening sing and scratch, eventually he wanders off to do the usual fox things, like find something to eat.

The lucky miner that found where ol' Golden Fox had been singin' could find a lot of gold dust shaken out on the ground. He could scoop up all that dirt with gold dust in it, wash the dirt away with his gold pan, and have a nice little pile of gold dust. Anyway, that's the story our visitor told us. Didn't really believe it, though. Sounded like a typical goldfields campfire tale to us.

A couple of nights later, after we had eaten and were just kickin' back by the fire, we noticed that the night had gotten very quiet. No wind, not much of any other night noises but the cracklin' of the fire. Then we heard this real faint singin' in the distance, sounded sorta like CQ CQ FOX de N6WG. The ol' timer didn't say what the Golden Fox's song would sound like, but we thought maybe this could be one.

So young Kenwood and I left our camp and struck out into the darkness, following that faint song. Good thing the moonlight was pretty bright, or we would have banged into trees all along the trail. As it was, I banged my head on a few low branches, while young Kenwood just trotted along under them. He couldn't seem to understand what my problem was.

The song had a lot of QSB, but we were able to follow it in the general direction of the Golden Fox's singin' place. Young Kenwood's hearing was a lot better than mine. After 'bout an hour of pokin' around in the dark with only the moon for light, we finally found the Golden Fox. He was sittin' up in a little clear patch on a hill, and just a singin' up a storm.

Well, like the story said, we left him alone. However, we did check for some land marks so we could find the place again in the daylight. Figgered young Kenwood's nose would help find our way back to it.

Next morning we went back, huntin' for the place where we saw the Golden Fox. It took a while, 'cause the darn landmarks looked different in the daylight than they did at night, but we finally found the right hill and the little clear patch.

Guess what. That old miner hadn't been tellin' us some wild tale. There really was some gold dust there on the ground along with fox paw prints. Well, we scooped up every scrap of dirt that had a chance of holdin' any gold dust and carried it back to our camp. Spent the rest of that day pannin' the dirt away from the gold dust so we could see what we had.

Let me tell you, that was a surprise. When the dirt was all washed away, we had a nice little pile of gold dust. Actually a lot more than we had dug up on our own so far. I put it in my little leather pouch, and young Kenwood and I hiked into town to see what we had. Went into the Assay Office where they weigh and buy the gold and had it checked. It was real gold, and we got a lot of money for it.

Well, nephew, like I said, young Kenwood and I hadn't been real successful as gold miners. So far, just a whole lot of hard work with not much to show for it. After seein' how much this gold dust brought us, we just looked at each other, thought a minute, then hoofed it down to the train station. After I bought us tickets home, there was just enough left over for a good dinner before the train left.

There you have it, nephew. That's how ol' Kenwood and I met the Golden Fox of the Mother Lode a long time ago.

The Golden Fox of the Mother Lode will sing again on March 5, 1997 at 0400 UTC, somewhere around hill 7035.. He will be singing CQ FOX de N6WG, just as in the story. You are all invited to try to catch a glimpse of this rare and elusive creature.

72, Bob N6WG and ol' Kenwood

NorCal 38 Special Mods

The following mods have been sent to QRPp and have been printed here to help you with experimentation and improvement in your 38 Special Kit. We strongly suggest that you use the 5 Watt mod by Mike Gipe instead of the one that is printed in the manual, we also suggest that you use the RIT mod presented here as well as the hookup of the TiCK Keyer. The origianal mods in the manual have all been improved by the presented here.

NC38S: Mods to the 5 Watt Mod
by Michael A. Gipe
(mgipe@reliablemeters.com)

Well, he said it was intended for experimentation! Ori, that is. Right on page 5 of the manual. I couldn't help myself. While the soldering iron was hot, I figured it wouldn't hurt to try one little thing.... It was the badger made me do it... the badger voices...Nils! Take them bacckkkkkk!

When I started to assemble the 38 Special kit, I decided that the 5 watt mod was so simple that I would just go ahead and put that in at the start. After assembling everything, I put the board on the operating desk and clip-leaded everything together. After playing with the receiver for a few minutes, I noticed that the smoke was leaking out of the IRF510.

Oh oh. What did I do wrong?

I clipped the FET out and checked it. It was shorted, but why was it shorted? I started checking my wiring and solder slinging. I double-checked with the schematic, and a light clicked on in my head (QRP light, of course, most normal people wouldn't have seen it in the noise). The MOSFET had a fixed voltage bias derived from the 12 volt power supply. I was running the rig from a 13.8 volt 20 amp power supply. Hmmm. After looking at the schematic some more, the noise in my head grew louder (It must have been the badgers) and I started thinking about modifications.

First, however, I did some experimenting with varying the bias using the circuit as shown in the manual. It behaves just as I expected it would. The bias circuit is set up to operate the MOSFET right on the knee of the gate-drain control curve. As expected, the exact operating point with a fixed DC bias will vary depending on the device temperature and manufacturing variations. By adjusting the bias divider resistors, I set up the amp for about 20 mA quiescent current with a supply of 12 volts. This worked very nicely, and put out about 4 watts of nice clean power (clean on a scope. I don't have a spectrum analyzer). After warming up the FET keydown until it was comfortably hot, the idle quiescent current was up to about 60 mA, still acceptable, but indicative of the temperature sensitivity of the knee. After cooling down, the current dropped back to 20 mA. The next experiment was very important. I increased the power supply to 13.8 v and kept the same bias resistors. The quiescent current jumped to 300 mA! This is because the bias voltage is set proportional to the power supply voltage, and the knee of the gate is very abrupt at this point. This, of course, is why my first FET self-destructed. It was dissipating over four watts without heat sink during receive.

The simple bias circuit used is thus very sensitive to power supply variations. The first improvement would be to move the bias divider over to the regulated 8 volt line, and adjust the divider values so that the quiescent current is between 10 and 50 mA.

But the badgers kept badgering. I thought, why not just DC couple the gate, since we have an 8 volt swing from the 74HC240 driver. The circuit is just a little

simpler. The biggest advantage is that the idle current during receive would be zero, saving battery power, and reducing noise in the receiver.

The mod is:

1. Remove R101
2. Replace C101 with a wire jumper.
3. Change C26 to 330pF. (Thanks to Paul Harden for this suggestion, which helps stabilize things.)
4. Carefully adjust TC2 for clean sine wave output.

The amplifier now runs with zero current during receive. Its power output varies smoothly from 4 watts with a 12 v supply to 5.3 watts with a 13.8 volt supply. The output is nice and clean and stable. This puts the FET into class D operation, and the impedance matching filter seems to be exactly right. (Thanks to Paul Harden for confirming this.)

Your mileage may vary. That's why you should experiment and report your findings to the list and QRPp. Ori built this radio so people could experiment and learn. 72, Mike K1MG

RIT Mod for the 38 Special

by Jerry Henshaw, KR5L
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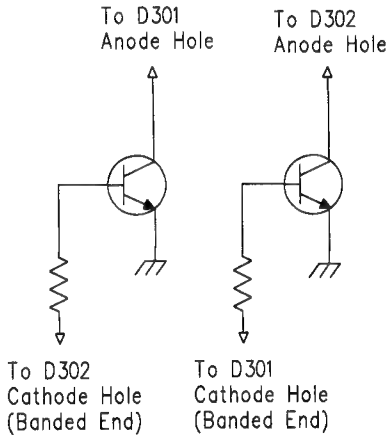
Here is the RIT mod I made to my low power version of the 38S. Here are the symptoms that this mod corrected in MY UNIT (your milage may vary) such are the vagrancies of electronics. I was experiencing considerable chirp at 300mw level into a 50 ohm dummy load. Also, I noticed when you turned the RIT circuit on, it would shift the transmit frequency by 1.5 khz — not a neat feature!!

I removed diodes D301 and D301 in the RIT circuit. and replaced them with two 2N3904 transistor switches. The culprit (in my opinion — subject to the scrutiny of better minds) is the R- line does not go all the way to 0 volts — mine drops to 50milivolts. The T- line however goes all the way down to 0 volts with some RF hash riding on it. The 50 milivolt differential will cause the RIT to tune about 1 - 2 khz when switched on.... causing the shift in transmit frequency. With the RIT turned off, the R- and T- lines are "wire ORed" together and the chirp is caused by the small difference in the ground reference point seen by the VXO circuit. Ori suggests using matched diodes for D301 and D302 — I felt the 50mv reference difference would be eliminated or reduced by using saturated transistor switches....it worked in my case.

Anyway here is the circuit ......



I made a little homebrew pc board and piggy backed it on top of the D301 and D302 mounting holes. You will notice I reversed the keying logic -R and -T because the 2N3904's invert the logical sense of the original circuit. I hand picked my transistors from my junk box by selecting ones with the highest hfe (gain), the ones I used had gains in excess of 200. I just wanted to make sure the transistors were driven to saturation.

This mod also works in the 5 watt version of the 38S. Let me know if this mod helped. Also, if anyone has a better (read easier) solution, please share it with the rest of us. 73's Jerry Henshaw,KR5L

TiCK Keyer Mod

by Brad Mitchell

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The instructions for the installation of the TiCK keyer chip as written in the manual for the 38 Special need to be modified.

Look at the schematic, and the lower right hand corner in particular. See the A designator. coming from C32 220 pF. Ok, see where it connects on the left side of the drawing at R19.

Anyway, we want the A on the right side to connect to the R19, C34 junction through a NEW 4.7K resistor.

Ok that said, right now, in artwork , C32 is connected to R19 directly, and that junction will have to be cut. Once Cut, you need to connect C32 to the R19, C34 Junction via a NEW 4.7K resistor.

"Cut the trace between C32 and R17, connect the NEW resister between the side of C32 you just cut, and the C34 side of R19 (the end towards the bottom of the board, viewed from the top)"

This Mod allows the TiCK keyer telemetry tones to be heard, where without it, they will not be heard, especially when there are signals on the band. 72, Brad WB8YGG

38S: Audio Level

by Ori Mizrahi-Shalom, AC6AN

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There have been some comments regarding the audio level of the 38S receiver. It can still hear S0 signals well, but the audio is not ear piercing... Here's what you could easily do: resistor R24 (in series with the headphones) is responsible for some audio level loss when low impedance headphones are used. It is 47 ohm in the kit, since we found that it reduces the noise level generated in the 5532A with certain low-impedance headphones. You may want to try lower values or short R24 with a jumper wire. Your milage may vary...72, Ori, AC6AN

38S Choke Changing Made Easy

by Daniel C Winkler, N7IVR

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Lowering the tuning range of the 38 Special is easy as pie. Add 5 turns to the choke. Here's how.

Orient the choke so that it reads correctly from left to right. The Yellow (4) band is on the left, silver on the right. Cut a 2 1/2 " (2" will probably be ok) piece of wire- I used 28 gauge from a 3 pak I got at Radio Shack years ago. Take the enamel off both ends. Make a tiny loop in one end and slip it over the RIGHT hand lead of the choke (the one with the silver band) and snug it up to the choke. Solder it.

Clip off the remainder of the choke's lead. Consider this end of the choke the BOTTOM, and stand it up. Looking DOWN at this thing, wind the wire around the choke CLOCKWISE for 5 turns. The wire fits nicely into the narrow middle portion of the dog-bone shaped choke. I measured 6.6 uH with 5 turns, 7.05 uH with 6 turns, and about 7.5 uH with 7 turns. Your mileage may vary. Start with 5 turns. Put it in the circuit and see if the coverage is what you want.

If the frequency is higher than you started with, then your turns go the wrong way, you have reduced the inductance from it's nominal 4.7uH. Perhaps your choke is from a different manufacturer. Or maybe they don't orient the color code the same way on each choke. Re-wind in the opposite direction. Try again.

When you're happy with your frequency range, put some epoxy on the choke to hold the turns. Or hot melt glue, nail polish, Q-dope, airplane cement or model paint. I'm sure you can do partial turns with this technique, too. Just dress the wire lead off at right angles to the body of the choke. Secure it when you've got what you need. 73, Dan

Winkler, N7IVR

38S: Board Pad #s vs. Functions
Stephen M Smith, WB6TNL
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I thought that a numerical list of pad #s vs. functions might be a helpful reference.

(1) Antenna connector "hot".
(2) Antenna connector ground.
(3) Power input, negative.
(4) Power input, positive.
(5) Keyer paddle common (ground). (TiCK mod. only.)
(6) Keyer paddle DIT input. (TiCK mod. only.)
(7) Keyer paddle DAH input. (TiCK mod. only.)
(8) PGM switch input. (TiCK mod. only.)
(9) Key line, input (not used if TiCK mod. added).
(10) Key line, ground.
(11) R.F. gain control pot., low.
(12) R.F. gain control pot., wiper.
(13) R.F. gain control pot., high.
(14) RIT switch, "RIT off". (RIT mod. only.)
(15) RIT switch, common. (RIT mod. only.)
(16) Tuning control pot., low.
(17) Tuning control pot., wiper.
(18) Tuning control pot., high.
(19) Receiver audio output.
(20) Receiver audio ground.

Enjoy and I hope this helps. 72, Steve

Improving the Receiver in the 38 Special
by Roy Gregson, W6EMT
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First off, I have the mono communications phones from Radio Shack, probably not as good as the Sony ones. So the receiver seemed kinda dead when the band was open, I had the af gain wide open, and there never was a signal loud enough to want to turn it down. So I shorted the 47 ohm resistor, R24, that helped some, and added a .1 cap across R19 which seemed to tune the filter to my phones, and there was an increase in gain. I haven't had a chance to get on the air again with it, but there is enough gain now to maybe need to turn the gain down on a strong signal. I added another .1 across the first one, and seemed to be a little more gain. I was pleased to hear it run my 5" speaker, although there was a low rumble like maybe the last cap was a bit too much. These changes seemed to make the crystal filter work better, like the desired sideband is more pronounced. But there is really no connection......just audio illusion !!

I did look at U5 with the idea of removing it and putting in an LM386, but figured the filter was a good idea, so left it alone. I added the parts as suggested by Paul in the output filter. The mysterious C505 is now a 560pf, C28 is a 1000pf. C29 is a 560pf. I get slightly over 5 watts out, easy to tune up, sine wave looks good on the scope too. So at this point in time, my only complaint would be the key clicks in the phones as others are complaining about. Try the rec mods and let me know what you think ? 72's/73's Roy

Another Way to Change Choke Values
by Mike McShan, N5JKY
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I tried Daniel Winkler choke changing mode for the 38s to get the desired frequency range - works great. I did a variation of his method that eliminates some repetition in soldering and de-soldering.

Prepare your choke as described in Daniel's post. However, add about an extra 1" or so of wire leaving the body of the choke at 90 degrees. Mount the choke so that it standing upright in the board and loop the end of the wire back to solder the end in the appropriate hole. The little bit of looping back here does not

seem to appreciably affect the inductance; however, it is important to keep the wire leaving the body of the choke at a right angle.

Now, check the frequency range of your 38s. If it not to your liking, you have enough "play" in the wire to easily add or remove a turn on the choke by passing the wire over the top of it. You may have to bend the choke downwards to get the extra turn of wire over the top. Once you get the frequency range you like, carefully remove the choke, glue the wire turns in place and trim away any extra wire. Using this method I was able to make my 38s tune from 10.100 to 10.125 MHz. 72,Mike, N5JKY

Adjusting the Tuning Range of the 38S

by Mal Goosey

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I went for broke and built my 38s with the 5 watt, rit, and tick keyer mods. I experienced the chirp and thump observed by others. the chirp is a slow (many seconds) change in frequency, which suggested a thermal effect. In measuring the voltage at the wiper of the tuning pot however, I found the same slow change. I also observed an instantaneous jump of 1.5KHz upon switching the rit on and off! Shorting the low end of the tuning pot to ground eliminated the chirp, so it is not the result of a thermal effect, and I think it must be due to rectification of rf in the diodes of the rit circuit, although where the long time constant comes from is a mystery. I considered the mod using saturated transistor switches in place of the diodes, but finally decided to bag the rit. This also allowed me to put a resistor from the low side of the tuning pot to ground of a value that puts the low end of the tuning range at exactly 10.100. With a 6.1uH choke for L1, my tuning range is 10.1 to 10.121. I also replaced R12 with a 2K pcb pot and cut the trace from R12 to C25 and connected the wiper of the pot to C25. I now have smooth control of the power output of the final amp. All in all, this is a fantastic little rig——but I still have the thump on key release—hi. 72, Mal Goosey, N7GS

A Simple Way to determine if TC-1 is at Minimum or Maxium

by Glen Leinweber

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Al Hunter wrote the following to the qrp-l group on the internet. "I can't seem to peak TC1. I get one small peak thru the tuning range of TC1 (I believe there should be 2 distinct peaks). Is there a simple way to determine if turns should be increased or decreased on the secondary of T1?"

I too had this problem. Its difficult to see if TC1 is at maximum capacitance or minimum. If your variable trimcaps are the same as mine, they are black, with an orange top. The black shell has a small flat on one side, and the orange top has an "X" screwdriver slot. It also has a small hole tucked close inside the X. I'd take this as an index, to show you what angle the capacitor's plate are.

My TC1 cap gave maximum signal with the index hole on the opposite side to the flat. Minimum signal occured with the index hole right next to the flat. In my case, that meant I had to remove one turn from T1. After that, TC1 gave two peaks as it should.

I've heard others say that these coils are a little big. One turn also needed to be removed from L2 as well. (Toroids are wound tight) 72, Glen

DIAGNOSTIC VOLTAGE MEASUREMENTS FOR THE "38 SPECIAL"

by Paul Harden, NA5N

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Voltage measurements are VDC unless otherwise indicated, using a DVM or voltmeter in both receive and transmit

modes. Due to variations in voltmeters and Vcc, voltages below are +/- 0.2v. The 38-Special measured has a 5W amplifier, but NO RIT or keyer mod. NOTE: U1-3 = U3, pin 3. On XMIT voltages, ensure you are connected to a dummy load.

U1 NE602 RCV Mixer

	RCV	XMIT
U1-1	1.4V	1.7V
U1-2	1.4	2.2
U1-3	0	0
U1-4	6.7	4.7
U1-5	6.7	4.7
U1-6	7.4	7.4
U1-7	6.6	6.5
U1-8	7.8	7.8

U3 NE602 TX Mixer/Prod. Detector

	RCV	XMIT
U3-1	1.4V	1.4V
U3-2	1.4	1.4
U3-3	0	0
U3-4	6.7	6.7
U3-5	6.7	6.7
U3-6	7.7	7.7
U3-7	7.0	7.0
U3-8	7.8	7.8

U5 NE5532 AudioFilter/Amp

	RCV	XMIT
U5-1	3.9V	3.9V
U5-2	3.9	3.9
U5-3	3.9	3.9
U5-4	0	0
U5-5	3.9	3.9
U5-6	3.9	3.9
U5-7	3.9	3.9
U5-8	7.8	7.8

U2 CD4066 Switch

	RCV	XMIT
U2-1	7.8V	7.8V
U2-2	7.8	0
U2-3	7.8	0
U2-4	0	0
U2-5	0	7.6
U2-6	0	7.6
U2-7	0	0
U2-8	0	6.6
U2-9	6.6	6.6
U2-10	6.6	6.6
U2-11	6.6	6.6
U2-12	5.6	0
U2-13	5.6	0
U2-14	7.8	7.8

U4 HC240 Drivers, PA and sidetone osc.

	RCV	XMIT
U4-1	5.7V	0V
U4-2	0	4.2
U4-3	0	4.0
U4-4	0	4.3
U4-5	7.8	3.8
U4-6	0	4.4
U4-7	0	7.6
U4-8	0	4.4
U4-9	0	4.4
U4-10	0	0
U4-11	7.8V	3.5V
U4-12	0	3.6
U4-13	5.7	0
U4-14	0	3.6
U4-15	0.6	3.8
U4-16	0	3.6
U4-17	7.8	3.8
U4-18	0	3.6
U4-19	0	0
U4-20	7.8	7.8

Q1 2N3904 RF Driver & bi-phase franistan

	RCV	XMIT
Q1-E	0V	0.9V
Q1-B	0.6	1.5
Q1-C	7.8	3.5

DIODES (-A= Anode/band end, -K = cathode)

D1-A	D1-K	D2-A	D2-K	D4-A	D4-K	D5-A	D5-K
4.8V	5.4V	4.8V	5.4V	5.7V	5.7V	5.7V	5.7 RCV
7.6	7.8	7.6	7.8	0	0	0	0 XMIT LP
8.1	7.4	8.1	7.3	0	0	0	0 XMIT - 5W

D6-A	D6-K	D7-A	D7-K	D8-A	D8-K	
5.7	6.1	0.1	0.6	0.1	0.6	RCV
0	0.5	7.6	1.5	7.6	3.9	XMIT, either power

D3-A 0-8V, depending on setting of the TUNE pot

D3-K 0V (ground)

AC VOLTAGES - Most of the *AC* voltages in the 38-S are too small to register on a DVM/voltmeter, except as follows: HC240 RF output at U4-12,14,16 = 0.14Vac on XMIT (approx.)

NE5532 Audio output at U5-1 registers about 0.05Vac on XMIT and about 0.03Vac on RCV with a moderately strong signal.

If you're having problems with your 38-Special ...Check the voltages listed above in both receive and transmit. Since most of the voltages are switched on and off fairly hard between RCV and XMIT, a problem should be evident. A measured voltage that is close to the above is probably OK. Voltages on the NE5532 are primarily the 1/2Vcc biasing (virtual ground), developed by R25, R26 and C38. GL, Paul NA5N

Remove a Turn on a Toroid the Easy Way

by Al Hunter, AA6SO
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The little depression on the orange (knob) did help to give some indication of the position of the capacitor plates. What I ended up doing was replacing the trim cap with one I had in the junk box which has a transparent top and I could see the plates. This showed me that I needed to remove a turn from T1. Then another idea....I didn't like the idea of having to unsolder and remove T1. So I scraped the insulation from two adjacent windings near the top and soldered a little jumper made from wire wrap. Now, TC1 has the proper peaks. What a great little radio. I will probably do the same fix at L2. Thanks again and 72/73. Al Hunter - AA6SO

K7TP Builds the 38 Special

by Grover Cleveland, K7TP
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It's been a tough road or at least a long one. The basic kit went together well but it soon became apparent that it suffered from many of the flaws that had been mentioned. So I read and reread the threads on the qrp-l to make sense of some of the diverse opinions about what worked and what didn't. From this came coherence and here are the lessons learned and solutions applied:

1) The chirp - I elected finally to just drop the RIT mod. That killed the chirping. Instead of an RIT I used a multi-turn 100k pot that was lying around and this will give me the resolution I need. If I regret this move later I can always put in the modified RIT circuit with the saturated transistor switches as suggested.

2) Poor sensitivity - I should have

noticed this the first time around because I've been bitten by this before: there was only one peak on TC1, a give away that the circuit was not resonant. I took two turns off the secondary of T-1 and voila, the same hot receiver people have been raving about.

3) TiCK Telemetry Tone Mod - There was some diverse opinion about this circuit. I put a 4.7K resistor from the right side of C32 (as seen in the schematic) to the right side of R19; I cut the board connection between C32 and R19 first. This allows both the receiver and the TiCK sidetone to sum at pin 6 of U5.

4) Diode biasing [note that you need to do the TiCK mod because you need U4C and U4D] - removing the 8V from the top of R1 and R2 and feeding that point instead with the inverting output from pin 5 of U4, shuts down forward bias to the diodes during transmit. Be certain that you jumper D8 which you removed during the TiCK mod. This jumper passes the R- output to U4D.

5) Direct coupling for the IRF510 - everyone should do this mod. It reduces idle current drain and helps to stabilize the final. While you're at it, stick a 560pF silver mica cap in C505. There was some suggestion that the ferrite bead should not be there so out it went.

6) Variable power output - replacing R12 with a 2K pot allows me to vary the power output from zilch to five watts.

To all those whose experiments led me to trying these mods, I thank you immensely. I'm a happy camper. The transmitter sounds good at 4 watts and the receiver hears everything my Index Labs QRP++ hears. Now on to mounting this radio in an enclosure (just as soon as I learn the size of the new digital display kit).

What a group! .073 Grover, K7TP

Adjusting the 38S VXO

by Jim Kortge, K8IQY (ex NU8N)
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Here is yet another spin on making the 38S VXO get down to the bottom of 30 meters (10.1 MHz) and cover a good range. I replaced the 4.7 uH choke with a 10 uH unit and put a 3-25 pf trimmer in series with it. I have 25 KHz of tuning range and can set the bottom end of the tuning right on 10.1 MHz. It's a bit touchy to adjust because both halves of the trimmer are hot with r.f., but it sure works well. Once adjusted, it seems quite stable, and if you hear something up above the top end, and it's really important to work, you can tweak the trimmer a bit and get up there also.

Anybody else brave enough to try it and report your results?? 72 and keep those mods going.....Jim

Linearize the Tuning on your 38 Special

by Dave Fifield, KQ6FR
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There are a couple of modifications you can do to help "linearize" the tuning on the 38 Special.

You may have noticed that the tuning is quite non-linear. The low frequency end of the tuning is all squashed up while the high frequency end is well spaced out. In fact, you'll find that fully half of the tuning pot's travel (at the high end) only covers about 2 to 3 KHz. If you have done the inductor change (to 6.8uH) then you'll more than likely want to "un-squash" the low frequency end of the tuning.

Here are two mods you can do (one or the other, not both!). My personal preference is the second one, your mileage may vary:

Frequency Coverage Modification A

1. Cut the (marked) PCB track that short circuits R301. R301 is the unpopulated resistor directly next to the pin 4/5 end of U1 (NE602). It probably looks like 'R30' on the PCB legend (silk screen) because there's a via hole right where the '1'

should be!!
2. Put a 1/4 Watt resistor that equals roughly half of the value of the tuning pot that you used into R301's position. So, if you used a 100 KOhm pot, you need to use a 47 KOhm resistor. If you used a 50 KOhm pot, you need to use a 24 or 27 KOhm resistor. You get the idea...
3. Smile, you're done!

What this does is actually reduce the tuning RANGE of the pot. You'll now find that your 38 Special only tunes from 10.100 to 10.122 MHz instead of from 10.100 to 10.125 MHz (approx. numbers)...BUT, the tuning will be much better spread out at the low end and more linear.

Frequency Coverage Modification B

With this mod, you don't loose any of the coverage range. It's only disadvantage is that there isn't a place for the extra resistor on the PCB directly.

The tuning can be made more linear by simply adding another resistor from the wiper of the tuning pot to ground! You just have to get the right value, that's all. I did some tests and found that 12 KOhm was about right. You can add this resistor either directly to the pot (as I did) or underneath the PCB between pins 17 and 18. You may like to make this componenet a small trim pot (20 KOhm should do) or a combination of fixed resistor with small trim pot (try 8.2 KOhm fixed with a 5 KOhm trim pot) to fine tune your particular rig.

On a historical note, I believe that this type of mod was one of the many put forward for the Norcal 40. I first used this technique in 1978 to make the fine tuning of VHF and UHF Wilkinson power dividers (made using PCB traces) easier. I'm sure I wasn't the first - it was probably used way back in the early days of tube development too! 72 es cu all on 30m, Dave Fifield, KQ6FR

A 38S Mod for Better Sideband Rejection & Filtering

by Glen Leibweber, VE3DNL
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This isn't a better crystal filter. But it should improve the sideband rejection, because it moves the peak of the audio filter up in frequency, allowing a larger frequency difference between the desired sideband and the undesired sideband. And this mod has steeper filter slopes too, so undesired signals should sound weaker.

Ori's original design is set at about 590 Hz. Some will find this frequency a little low, others will find it just fine. This mod moves the design up close to one kilohertz. Some may find this too high.

There are three things that have to be done to the 38s to move the design frequency up to 1 Khz:
(a) The sidetone frequency has to go up.
(b) The peak in the audio response has to move up.
(c) The TX/RX shift in U3's 12 Mhz BFO oscillator has to be widened.

(a)The sidetone shift:

This is pretty easy. The frequency of the audio sidetone is set by C31 and R16. Adding some resistance in parallel with R16 will raise the sidetone frequency. About 100K in parallel with R16 will raise the sidetone frequency to about 1 Khz.

If you're using the TiCK keyer sidetone, sorry, it can't be shifted. You're stuck with 650 Hz.

(b) Audio response peak shift:

This one is more difficult, because some parts have to come out, and replaced with others of different value. But no traces need be cut, so its not too bad. All the parts substitution involve U5B, the bandpass filter. Ori's original design comes out with a gain of 32, center frequency of 589 Hz, and Q of 6.1 The new component values change the bandpass filter to a gain of

34, center frequency of approx 1 Khz, and Q of 6.2

Component	Old Value	New Value
R21	510	680
R22	390	390 Hey, its the same!
R23	33k	47K
C35	0.1uf	0.047uf
C36	0.1uf	0.047uf

In addition, anyone can improve high frequency rolloff by substituting the old C14 value from 0.01uf to 0.1uf. This is a good idea, even if you've staying with Ori's original filter. And you can replace that big 22uf capacitor @ C15 with a 0.1 uf capacitor as well, to give you better low frequency attenuation.

For even more filtering, see the mod to U5a below.

(c) The TX/RX BFO frequency shift:

The BFO local oscillator, inside U3, switches frequency every time the key goes down. D6 shorts out C21, decreasing the BFO frequency by about 600 Hz. We now want to have a frequency change of about 1000 Hz. This gets a little tricky, because we also want this BFO frequency to be offset from the I.F. crystal filter by about 1000 Hz while receiving (perhaps a bit more).

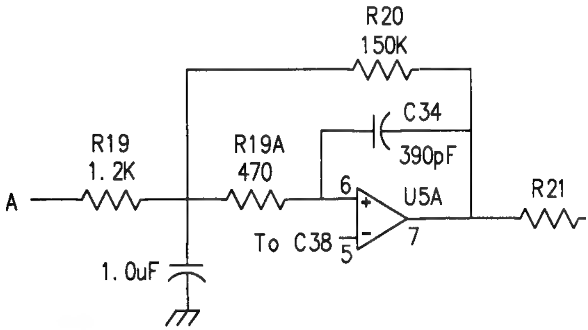
See if you can follow this: Ori's first mixer inverts sidebands. He's designed the relationship between the I.F. filter and the BFO frequency so the BFO is above the I.F. (remember, this oscillator shifts down while transmitting). So, at the I.F. frequency, the lower sideband is stronger than the upper sideband. But since the 1st mixer inverts the sidebands, @ 10.116 Mhz, the upper sideband seems the strongest (I hope). Whew!

To get better sideband suppression, we want to move the BFO further above the I.F. center frequency, at least while the rig is receiving. That means we should make C21 smaller. You might want to replace C21 with a 50pf trimmer capacitor so you can tune the BFO shift (between TX and RX) to exactly 1000 Hz. I've been playing with xtal filters, and getting a narrow bandwidth is tricky...a new xtal filter may require more diddling with BFO transmit/receive frequencies.

Smile, you're done.

OK, had enough yet? Having fun yet? No? You ARE a glutton for punishment, read on, else you can stop here.

U5A is a simple gain stage with a simple one-pole low-pass filter that cries out for enhancement. But this will require some printed-circuit-board surgery, and some jumper wiring on the bottom of the board. Not for the faint-of-heart. This mod will enhance U5A into a 2nd order low-pass filter, with a nice peak at 1 Khz. You may end up with too much gain here, since the peak response is about 3 times the low-frequency gain.



Notice that there's a new resistor (R19A, 470 ohm) and capacitor (1.0uf). Some trace cutting will be necessary to include R19a into the original circuit. Surface-mount components were used in my rig. All mods can be done to the bottom side of the board.

I have tried this filter, and improved out-of-band rejection is noticeable, but still could be better. Once again, the required PCB surgery around U5A takes some planning and dexterity. 72, Glen VE3DNL

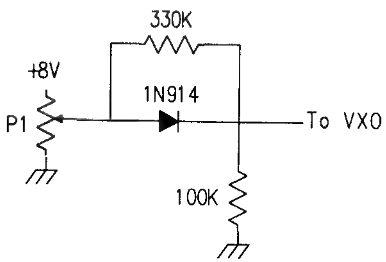
NC38s:Linearized Tuning CCT

by Glen Leinweber, VE3DNL
leinwebe@mcmail.CIS.McMaster.CA

Doug has thrown out the 38s DX challenge. That means many will be lurking down at the bottom end of the band, where the 38s's tuning range is pretty quick.

The tuning pot controls the D.C. VXO voltage going to the 1N4004 tuning diode. One suggested solution to help linearize the tuning range adds a resistor from wiper to ground. Good idea. This resistor will most affect the top end of the band, where tuning is very slow. But the bottom end could have still slower tuning.

So we need a non-linear element to give us something like an exponential rise in VXO voltage, while the pot wiper voltage rises linearly. Sounds like some kind of diode fits the bill. Here's one possible circuit:



The diode will most affect the tuning range down at the lower end of the band, stretching it out. You'll lose a little frequency range, because the VXO voltage can't get all the way up to +8v. So the rig won't go quite as high in frequency as it did before.

You could use a 1N914 type diode here, but a RED light-emitting-diode will extend the slower tuning a little higher in frequency, a GREEN L.E.D. will extend a bit more.

You can play with the two resistor values to change the tuning effect. Decreasing the 100k resistor will slow the tuning more, as will increasing the 330k. 72, Glen, VE3DNL

Variable Output Mod for 5W 38 Specials

by Brian Kassel, W5VBO
bkassel@dancris.com

Here is the way that I did a variable TX power modification the my NC38S. It only applies to those rigs which have undergone the high power mod; that is, the IRF510/511 has been added.

What it does:

This mod allows the TX power to be completely variable from milliwatts up to full output. The maximum power desired point can also be set.

How it does it:

The mod consists of adding a pot in such a way that a variable D.C. voltage, or bias, is added to the gate of the final FET. By varying the pot, the D.C. voltage at the gate can be varied from almost 0V (lowest power out) up to about 5.5 volts or so (highest power out).

The parts required are:

1.) 1 each pot, described below
2.) A 22K (depending on power limit requirements) 1/4 wattresistor
3.) A .1 UF capacitor at C-101, if you removed it per the Paul Harden Mod.
4.) Oh yes, some wire too to hook up the pot.

Micro instructions for the knowledgeable/impatient:

The mod only requires the addition of a 25K to about 100K pot. For this mod, the taper probably doesn't matter very much. I used a 50K, linear taper unit. One end of the pot goes to ground, one end goes to the cathode of D-7 via an added 22k 1/4 resistor. This resistor sets the highest available TX power out when the pot is set for maximum. The center goes to the junction of R-102 and C-102. This junction provides a +8 VDC when the key is down (R-). This voltage is varied with the pot, and supplied as the bias to the FET at the junction of R-102 and C-102. You must remove R-103 also, which frees up the circuit for the mod.

Doing the mod, step by step :

1.) Replace C-101 with the capacitor that you may have removed per the Paul Harden Mod. Or use a new one if you killed the little beastie on the way out.
2.) Remove R-103, we will use the holes left by the removal of the part to connect the new potentiometer.
3.) Solder one end of the 22K resistor to one end of the pot.
4.) Solder a wire to the other end of the resistor, and run it to the cathode or banded side of D-7. CAREFULLY solder the wire.
5.) Run a wire from the other end of the pot, to TOP hole, where R-102 used to be. This hole should be ground. Solder both ends of the wire.
6.) Run a wire from the center of the pot to the BOTTOM hole, where R-102 used to be. This is the connection to the junction of R-102 and C-102. Solder both ends.

Smoke Trapping Measures:

1.) Double check everything.
2.) See above

FINI:

With the rig turned on and keyed, measure the DC. voltage at the junction of C-102 and R-102. As you turn the pot, the voltage should vary from about 0 to about 5.7 volts. If you get maximum volts when the pot is CCW rather than CW, just reverse the connections at both ends of the pot. If you find that at the maximum setting of the pot you have too much output power, then make the 22K resistor larger. If you find that at maximum setting you don't get enough output then, oh heck, you know what to do, right?

We already know that some of the final FET's are hotter than others, so of course your mileage may vary, as they say in Texas.

Credits.

The original idea for this mod came from the almost-famous Dan Tayloe at our last ScQRPion get together. I just kind'a worked out the physical details.

There are of course other methods out there I am sure on how to accomplish the same end. This is simply the way that I wound up doing mine. 72, Brian D. Kassel

K8IQY's Optimized 38 Special

by Jim Kortge, K8IQY
PO Box 108
Fenton, MI 48430-0108

First of all, I'd like to say that I have had many, many private conversations over the past few weeks with Ori Mizrahi-Shalom, AC6AN, and Glen Leinweber, VE3DNL about many of the changes that I have included in this article. Glen is the one responsible for all of the changes to the audio amplifier, and these were posted to the QRP-L gang via one of his posts. These discussions have been both enlightening and most useful in working out some of the details. I also have included many original ideas that we never got around to discussing, due to other priorities in our lives.

Here is a rundown of the changes in my version of an "optimized" 38 Special. I'll list them, and then take them one-by-one and discuss how to implement each,

with details on building.

Modification Overview

Optimized front end filtering, to reduce 12Mhz bleed through

Adjustable VXO lower frequency setting capability

2 pole, 500Hz bandwidth crystal filter

900 Hz audio filter

Optimized transmit preamp stages

IRF510/MTP3055E 4 watt final amplifier

Optimized final low pass filter

TiCK keyer implementation

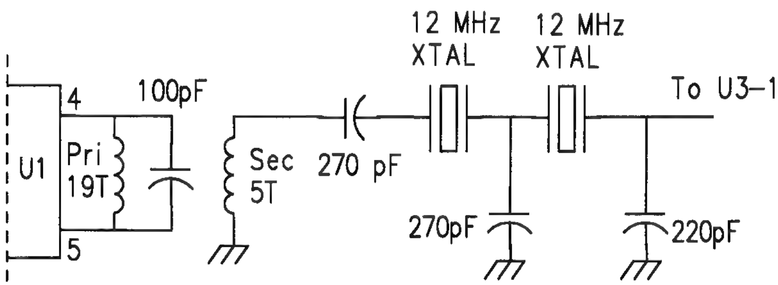
The reason for this order is that is basically follows the layout of the schematic, and the radio. Hopefully, it will aid in following and understanding what the changes are, and why they were made. Each modification will list the original parts affected. Then I'll describe what needs to be done to duplicate my 38S.

Optimized front end filtering:

Parts affected - T1 and C4. The reason for this change was to minimize the mixer U1, and keeps the bandwidth of the input filter as narrow as practical, consistent with adequate signal coupling.

Adjustable VXO setting capability:

Parts affected - L1. The reason for this change was two fold. I wanted to get as much range out of the VXO as was practical, and easily adjust the lower end to 10.1Mhz. This was accomplished by making L1 a 10uH choke connected in series with a 5-45pF trimmer capacitor. The choke was installed vertically, using the right PC board hole. The trimmer was installed vertically also, using the left PC board hold. The lead from the top of the choke was connected to the top of the trimmer, and the job was done. A 6.8uH choke would also work, but I didn't have any of those. The lower end of the band can be easily set by adjusting the trimmer. With this arrangement, I get 23Khz of coverage. As a side note, my 38S does not have the RIT installed. I didn't feel it was needed with the limited coverage of the main tuning.



amount of feed through that I was hearing from stations on or near 12Mhz when band conditions were enhanced. Input transformer, T1, is wound with a 2 turn primary and a 17 turn secondary. Capacitor C4, changes value from a 0.01uF, to a 10pF unit. The combination of tuned transformer secondary and coupling capacitor match the input impedance of

2 pole, 500Hz bandwidth crystal filter:

Parts affected - C9, X2, R6, C10, C17, X3, C21, R9, and D6. None of these original parts are used except R9, which will be installed vertically. More on that later.

Note the schematic of the new filter. It uses 2 series mode crystals in a mostly conventional "ladder" arrangement. The only departure from a tradi-

tional ladder configuration is the output capacitor which is a parallel element, instead of the usual series element. This was done to properly match the input of mixer U3, which is 1500 ohms.

I used a transformer to get the 750 ohm push-pull output of U1 (pins 4 and 5) down to 50 ohms to drive the filter. The primary is 19 turns, wound as close together as you can get them, using #26 wire on a FT37-2 core. The secondary is 5 turns, wound in the gap left by the primary. I've got a 100pF cap across the primary to tune it to 10.1MHz. As you can see, the secondary drives a 270pF cap in series with the first 12MHz crystal, then another 270pF to ground, the second 12MHz crystal in series with the first, and a 220pF cap to ground on the output of the second crystal. So, a conventional ladder setup with crystals and caps, except for the final cap which is a parallel element instead of being in series. This is needed to match the 1500 ohm load at pin 1 of U3.

Traces to cut:

Make a cut on the trace that connects between U1 pin 4 and X2 at the indicated trace cut area. This isolates the primary of the new transformer so that it is connected to U1 pin 5, only.

Make a cut somewhere in the middle of the trace going between T401 secondary and the crystal, X401 bottom pin. This is where the first 270pF will get soldered. The second 270pF gets soldered from the X401 upper pin location to the ground area to the left of that pin.

Make a cut in the middle of the trace going from crystal, X2 bottom pin and U2 pin 1 locations. Connect a jumper from U1 pin 1 to X2 upper pin location.

The transformer installs with the primary leads in the holes that Ori provided. They are the two holes, vertically oriented to the left of center of the T401 outline, when looking down at the component side of the PC board. The secondary uses the two lower holes Ori provided, within the outline, to the right of center. This will ground one lead, and attach the other to the 270pF capacitor on the input of the filter.

The 100pF capacitor which resonates the primary of T401 goes on the bottom on the PC board along with the two 270pF capacitors, as described above. The 220pF output capacitor goes in the C10 location. A wire is used at the C17 location.

This takes care of the filter itself, but to make it work properly, we have to make changes to the second mixer, U3, also. (Nothing is ever easy is it!)

A third crystal is used for X3. At the location of capacitor C21, we install a 4.7uH choke connected in series with a capacitor of between 82pF and 120pF. The capacitor value depends on where the crystals in the filter, and X3 are in frequency, relative to each other. I ended up using a value of 100pF, and the passband was just about perfect. Some experimenting will be required here, or just use a 100pF value and see how it sounds. The choke is installed vertically in the left hole provided for C21, the capacitor is installed vertically too, in the right hole. The tops are connected together. This point will also be connected to the switching transistor described below.

Finally, to make it work, we need a transistor to switch the capacitor out during transmit so that the offset is correct. Exactly the same approach Ori used. However, I found that diode D6 didn't switch well enough, so a 2N3906, PNP transistor was used. Install R9 in it's right most hole, and leave the vertical lead for a moment. Bend the emitter of the PNP transistor so that it is pointing 180 degrees from the base and collector leads. Install the transistor base into the hole marked for the cathode (bar symbol) of diode D6. The collector lead can go into one of the spare ground holes nearby. The

emitter is connected to the top lead of resistor R9, and the the resistor lead is also brought around the transistor case and attached to the junction of the 4.7uH choke and the 100pF capacitor.

This completes the filter installation. For reference, the crystals I used are from Mouser, part number 520-HCA1200-S, and are a 12 MHz series unit made by ECS. I also bought 4 cyrstals made by Fox, but they are lower in Q than the ECS units, and are not recommended.

There is one artifact with this configuration. The transmit offset is shy of the required 900Hz by a few hundred hertz. What does this mean. If you call a station, he will probably use his RIT to tune you in optimally. If you call CQ, the returning station will be about 350Hz lower than you would like him to be. Don't retune him, cause you will find him chasing you all over the band. This small problem will eventually be rectified, but at the moment, its solution is waiting to be discovered!

900 Hz audio filter

Parts affected - C15, R21, C35, C36, and R24. These changes should be made if the 2 pole crystal filter is used. Otherwise, the passband tuning established earlier will not be correct. Capacitor C15 uses a value of 0.1uF instead of the original 22uF. This reduces the low frequency coupling into the filter. Resistor R21 uses a value of 680 ohms. Capacitors C35 and C36 are 0.047 or 0.05uF, depending on what you have in your junkbox. Either will work fine. Resistor R24 is a wire to increase the output audio level for lower impedance headphones.

Optimized transmit preamp stages

Parts affected.- L2, C25 and C26. The number of turns on L2 is shown as 20 turns. My experiments have shown that this is one too many. L2 should be wound with 19 turns to get it to resonate correctly with the component values specified. To reduce the low frequency coupling from the 2N3904, pre-driver to the U4A stage, capacitor C25 is reduced from a value of 0.01uF to a 330pF unit. This change will prevent the transmit control waveform from being passed through the succeeding stages. I think this is one of the mechanisms responsible for the IRF510 heating problem posted to the QRP-L reflector. Capacitor C26 should also be a 330pF unit to properly load the output of U4A. A 270pF capacitor should be added to the output of the U4B stage. This capacitor can be installed either on the bottom of the PC board, or if you do your final amplifier using my approach, you can install this capacitor in the top holes provided for R101 and R103, since these parts are not used.

IRF510/MTP3055E 4 watt final amplifier

Parts affected - C101, C102, R101, R103, and Ferrite Bead. Although most will probably use an IRF510 for the final, I used a Motorola MTP3055E MOSFET. I have several of these, partly because Motorola has a PSPICE model available for this device. It is not unlike the IRF510/511 series of devices.

First, cut the trace on the bottom of the PC board as indicated for the original 5 watt modification. In my version, C101 is not used, a wire jumper is used instead. A wire jumper is also installed for C102. This grounds the lower end of the 220 ohm resistor (R102) directly. Another one of the mechanisms responsible for the excessive IRF510 heating may well be the effect of using C102 and R103. These components integrate the 0 to 8 volt r.f. switched drive to the gate of the IRF510, causing the bias on the gate to run at nominally 4 volts. On many units, this bias level can cause excessive drain current. R101 is not used, nor is R103.

I also did not use the ferrite bead on the gate lead as shown in the original modification. My reading has lead me to

believe that this causes instability, instead of reducing it.

This final amplifier implementation, along with the optimized low pass filter, renders a final that is clean, efficient, and free from parasitics. Mine runs 3 watts when on battery power, and 4 watts when on the bench supply at 13.8 volts. More importantly, I can run solid carrier for 30 seconds, and the MTP3055E is just slightly warm to the touch, using a small, finned, heatsink.

Optimized final low pass filter

Parts affected - C505, L3, and L4. There have been numerous posts to the QRP-L reflector regarding whether to use a capacitor at C505, and if so, what its value should be. I ran my filter modeling program and designed a low pass filter, which preserved the original values for C28, a 820pF capacitor, and C29, a 560pF capacitor. My output filter uses another 560pF capacitor for C505. In addition, inductors L3 and L4 are wound with 13 turns, instead of the original 8 and 14 turns respectively.

One of the objectives that I wanted to achieve was to reduce the 12mhz component getting through the filter, since this is one of the unwanted byproducts coming out of the 2nd mixer during transmit. The 12Mhz component is not highly attenuated by the filter in the input of the 2N2904 pre-driver stage, so the output filter must take care of as much of what get through as possible. Based on testing with the signal generator, this filter is about a good as you can get for 5 poles. The 12Mhz component is attenuated about 15 dB, without substantially reducing the 10.1Mhz component.

TiCK keyer implementation

Parts affected - D8, R15, R16, C31, R17, C32, and R18. This modification starts with cutting the PC trace between U4E and resistor R17. Just follow the instructions in the 38S manual. Another trace needs to be cut, which disconnects a side of capacitor C32, so that it no longer feeds point "A", as shown on the schematic. The correct location involves the right most end of C32 (looking at the bottom of the PC board) from the trace that connects capacitor C15 to resistor R19. This disconnected point is then rerouted to the other side of R19, using a wire on the bottom of the PC board. Components D8, R15, R16, and C31 are not installed. Components R17, C32, and R18 will use different values from those shown on the schematic.

Install the TiCK keyer chip along with the components shown on the TiCK schematic. R17 will need to be a 10M resistor. C33 uses the original 0.01uF value. R18 becomes 4.7K, and C32 uses a 0.1uF capacitor. These values give a good sidetone telemetry level, but are still a bit too loud when transmitting. Somewhere, there seems to be another path that the audio is getting into the audio amplifier, other than the path we just provided.

That's all the changes that I have installed to date. How all of it performs is a matter of opinion, but in the week that I have been running this configuration, I am delighted with the results. I'd still like to find the source of the ubiquitous "thump" that we all are hearing. And I'd like to track down the reason the sidetone is so loud during transmit. But these are minor annoyances.

Overall, the 38S is a really solid performer, even without the changes that I have made. I admire and appreciate the clever design Ori brought to the original configuration, and forethought to include room and allowances on the PC board for just the kind of changes I have described. With the changes, this 'lil rig really performs. I've had numerous contacts with it, and repeatedly am astonished at the 579 to 599 reports I get, and the comments about being impressed with what 3 watts can do. Copyright - February 23, 1997, by Jim Kortge, K8IQY

QRP HINTS & KINKS

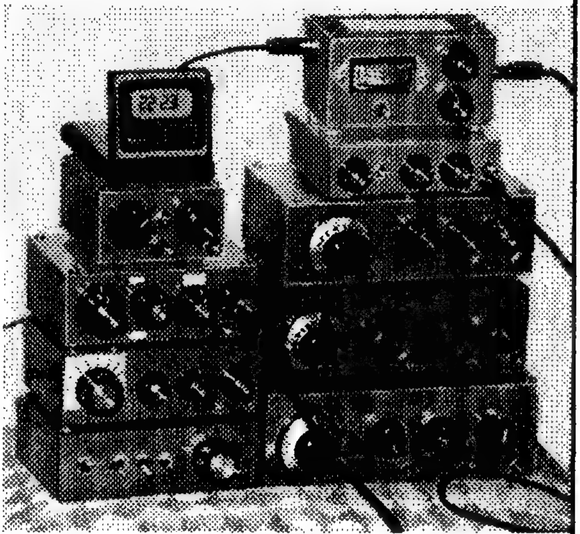
A NorCal Exclusive

Illustrated by Paul Harden, NA5N

#3 Making QRP Rig Enclosures

With the phenomenal success of NorCal's "38-Special," there is renewed interest in how to "package" a kit. In this installment, we'll explore making enclosures and general construction practices that can be applied to any board kit (38-S, NN1G GM's, etc.) or for equipment built from scratch.

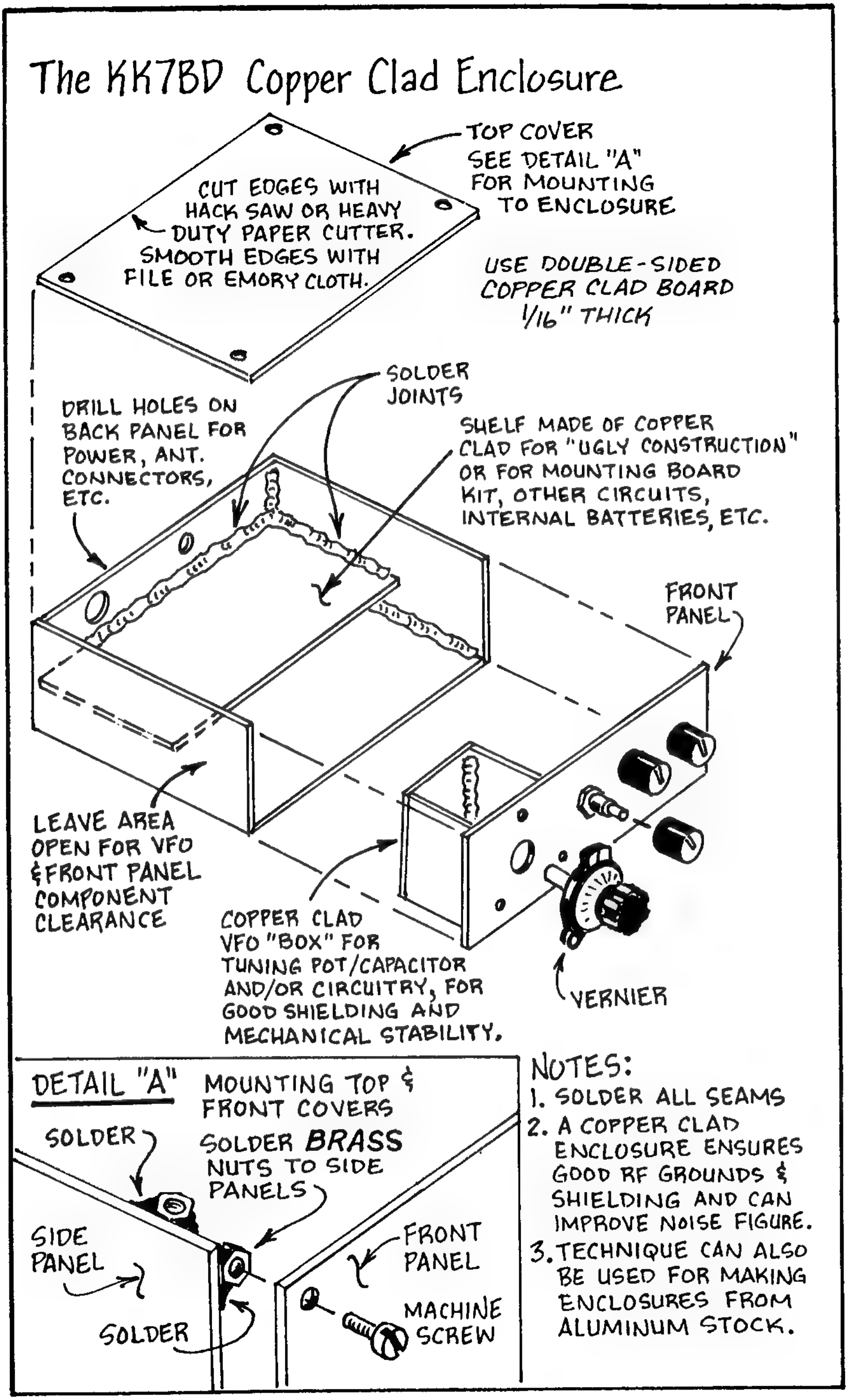
Let's start with the best ... the totally homebrew QRP station of ***Dan Tayloe, KK7BD*** in Pheonix, AZ. Dan sent me this photo of his shack and an excellent description of how the chassis are constructed. The black and white photo here just doesn't show the beauty of this station as the color original does. For size comparison all enclosures are 1½ inches high and most are totally homebrew circuits using "dead bug" construction.

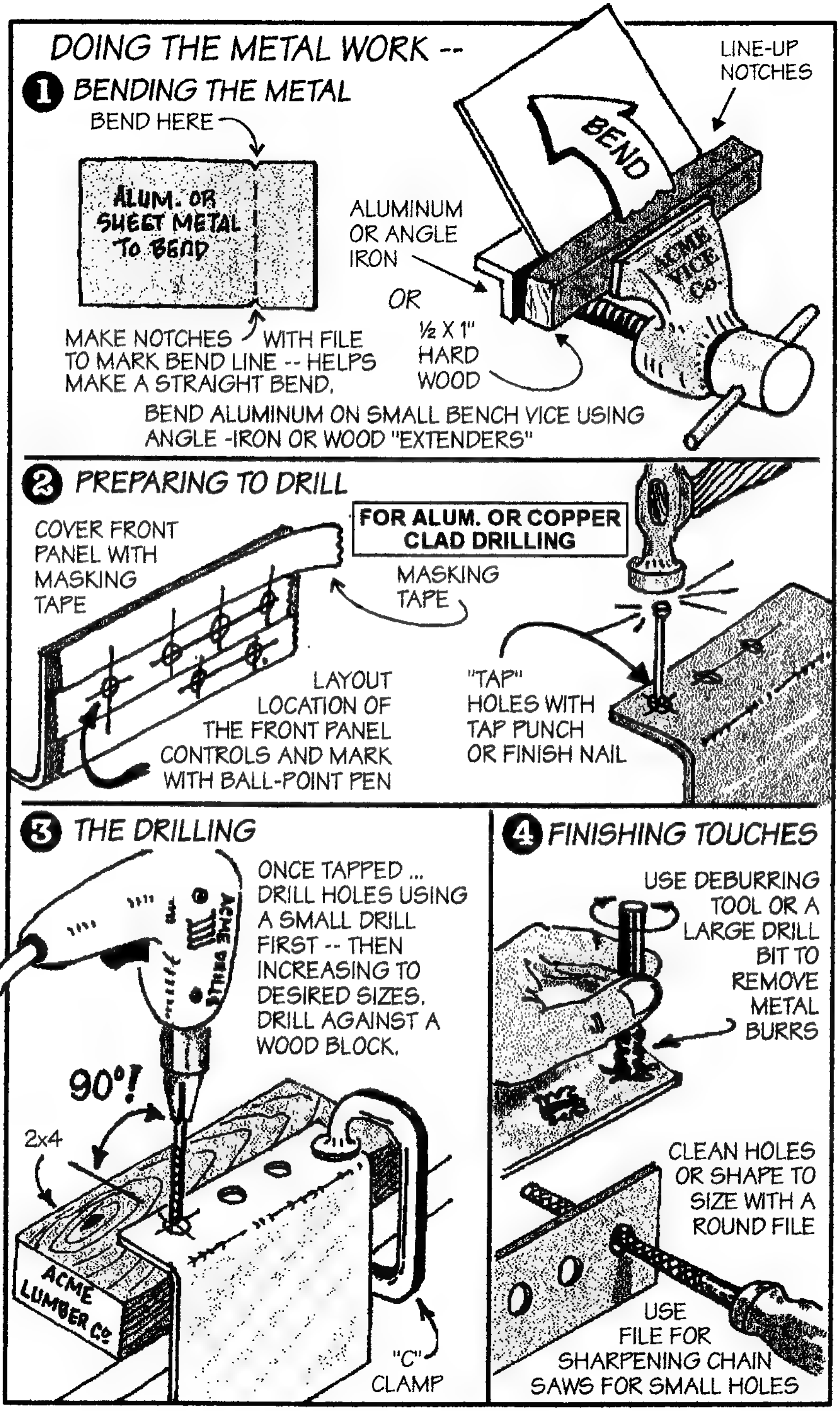


Dan Tayloe, KK7BD's homebrew QRP station with several transceivers, SWR/Power meter, tuner, SCAF filter, keyer and Dan's "Fox Rig," all made from double sided copper clad.

SOURCES OF COPPER CLAD BOARD

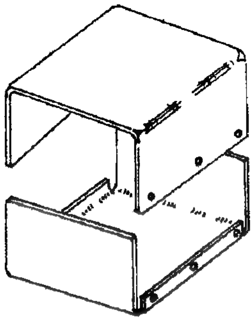
Copper clad board is available either single-sided or double-sided. Radio Shack carries copper clad board in various sizes. Pieces can be purchased more economically from the mail order electronic companies, such as Mouser (1-800-346-6873), DigiKey (1-800-DIGIKEY) and Kepro Circuit Systems (1-800-325-3878). Surplus dealers also offer "grab bags" of copper clad pieces at very reasonable prices and usually includes fairly large pieces, such as ALL Electronics (1-800-826-5432). If there is a circuit board manufacturer in your area, check with them, as they are usually glad to have you cart off their "trimmings," many of which are of suitable size. Double-sided copper clad, 1/16" thick, is preferred for building enclosures.


The KK7BD Copper Clad Enclosure
TOP COVER
SEE DETAIL "A"
FOR MOUNTING
TO ENCLOSURE
CUT EDGES WITH
HACK SAW OR HEAVY
DUTY PAPER CUTTER.
SMOOTH EDGES WITH
FILE OR EMORY CLOTH.
USE DOUBLE-SIDED
COPPER CLAD BOARD
1/16" THICK
SOLDER
JOINTS
DRILL HOLES ON
BACK PANEL FOR
POWER, ANT.
CONNECTORS,
ETC.
SHELF MADE OF COPPER
CLAD FOR "UGLY CONSTRUCTION"
OR FOR MOUNTING BOARD
KIT, OTHER CIRCUITS,
INTERNAL BATTERIES, ETC.
FRONT
PANEL
LEAVE AREA
OPEN FOR VFO
& FRONT PANEL
COMPONENT
CLEARANCE
COPPER CLAD
VFO "BOX" FOR
TUNING POT/CAPACITOR
AND/OR CIRCUITRY, FOR
GOOD SHIELDING AND
MECHANICAL STABILITY.
VERNIER
DETAIL "A"
MOUNTING TOP &
FRONT COVERS
SOLDER
SOLDER BRASS
NUTS TO SIDE
PANELS
SIDE
PANEL
FRONT
PANEL
MACHINE
SCREW
SOLDER
NOTES:
1. SOLDER ALL SEAMS
2. A COPPER CLAD
ENCLOSURE ENSURES
GOOD RF GROUNDS &
SHIELDING AND CAN
IMPROVE NOISE FIGURE.
3. TECHNIQUE CAN ALSO
BE USED FOR MAKING
ENCLOSURES FROM
ALUMINUM STOCK.


DOING THE METAL WORK --
1 BENDING THE METAL
BEND HERE
ALUM. OR SHEET METAL TO BEND
LINE-UP NOTCHES
BEND
ALUMINUM OR ANGLE IRON
OR
½ X 1" HARD WOOD
ACME VICE Co.
MAKE NOTCHES WITH FILE TO MARK BEND LINE -- HELPS MAKE A STRAIGHT BEND.
BEND ALUMINUM ON SMALL BENCH VICE USING ANGLE -IRON OR WOOD "EXTENDERS"
2 PREPARING TO DRILL
COVER FRONT PANEL WITH MASKING TAPE
FOR ALUM. OR COPPER CLAD DRILLING
MASKING TAPE
LAYOUT LOCATION OF THE FRONT PANEL CONTROLS AND MARK WITH BALL-POINT PEN
"TAP" HOLES WITH TAP PUNCH OR FINISH NAIL
3 THE DRILLING
ONCE TAPPED ... DRILL HOLES USING A SMALL DRILL FIRST -- THEN INCREASING TO DESIRED SIZES. DRILL AGAINST A WOOD BLOCK.
90°!
2x4
ACME LUMBER Co
"C" CLAMP
4 FINISHING TOUCHES
USE DEBURRING TOOL OR A LARGE DRILL BIT TO REMOVE METAL BURRS
CLEAN HOLES OR SHAPE TO SIZE WITH A ROUND FILE
USE FILE FOR SHARPENING CHAIN SAWS FOR SMALL HOLES

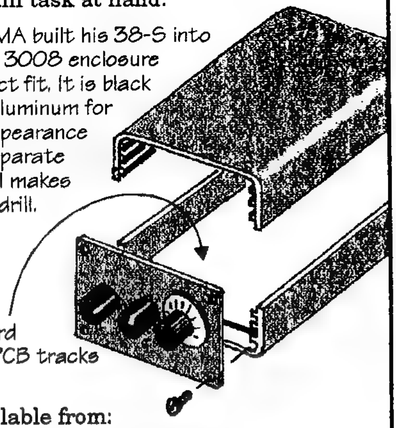
USING "READY MADE" ENCLOSURES

Radio Shack, TenTec, and most mail order vendors carry a line of small pre-made enclosures ranging from $5 to $20. These are easy to use, with drilling the front and rear panels the main task at hand.



BASIC "CLAM SHELL" ENCLOSURE
(Radio Shack, LMB, etc.)

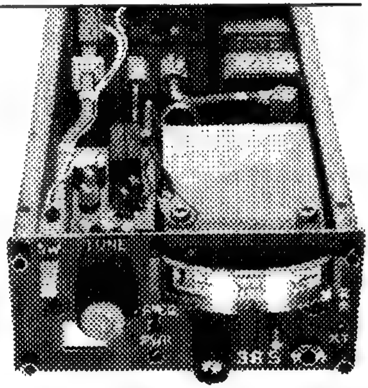
Vern W6MMA built his 38-S into this Model 3008 enclosure for a perfect fit. It is black anodized aluminum for a sharp appearance and the separate front panel makes it easy to drill. About $15.



38-S Board Fits into PCB tracks

Available from:
Context Engineering
Santa Clara, CA • 408-748-8676

The NA5N 38-Special



I built my 38-S with mostly junk box parts, and presented here to spawn some ideas. An old telemetry receiver ($20 hamfest item) was the source of parts. An aluminum support bar (1½x¼x19") was cut to form the side panels, to which everything is mounted by drilling and tapping 4-40 holes. (¼" wood could have been used). An aluminum shelf runs the length at half the height. The edge meter (from the receiver) is mounted to the top of the shelf along with the *external* IRF510 amplifier box (made from copper clad) and the two 9v batteries (for 300mW only). The 38-S board is mounted upside down on the underside of the shelf, along with the built in paddles (not installed when photo was taken). RF between the IRF510 amp. and 38S PCB is routed through semi-rigid coax and SMA connectors (from the telemetry receiver). An on-off and amplifier bypass switch on the amplifier assembly is activated by a long push rod to the front panel, made from clear plastic and a red LED to show when the amplifier is enabled (upper left hand corner). The meter is switched to show either the frequency (from the tune pot voltage) or output power. The circuit board behind the tune pot does this, built ugly. The 38-S measures 1.7"H, 3.5"W and 5.5"D.

The front panel was painted with "anodized bronze" (sliding glass door touch-up paint); white rub-off letters from an office supply was used for the labeling. It gives the 38-S that "avionics" look. The meter face was removed and customized for the 38-S. The aluminum for the covers (not shown) was cut from a CB enclosure bought at a flea market for $5 (which also contained a MRF476!).

72, Paul NA5N@Rt66.com

Next issue ...
Painting & labelling enclosures

38 Special Transceiver Kits

NorCal is kitting the 38 Special Transceiver that was designed by Ori Mizrahi-Shalom, AC6AN and was featured in the Winter issue of QRPp, 1996. The 38 Speicail is a board and parts kit, with all parts that fit on the board for the basic kit, plus a doubleside, silkscreened, soldermasked, plated through commercial quality pc board. The builder will supply connectors, controls, and case, plus parts for the mods.

Ori has provide extra space on the board so that the kit can easily be modified to put out 5 W with a transistor that is available from Radio Shack! And, you can add a keyer chip that is availble for $5 and have an automatic keyer in your rig. Plus, there are many mods that have been done by the early builders and are featured in the Spring issue of QRPp.

The best thing about this kit is the cost! Only $25 for the kit and 20 page comprehensive manul. Shipping and handling is $3 per kit for US addresses, $5 for DX addresses. To order, send your check or money order, US Funds only, made out to Jim Cates to:

Jim Cates
3241 Eastwood Rd.
Sacramento, CA 95821

Orders will be shipped in the order that they are received.

Back Issues of QRPp

Back issues of QRPp are available in bound volumes only. They are bound in 1 year sets with a plastic finger binding and have a heavy card stock cover. Sets will not be broken up, and are available in 1 year sets only. The following are available:

QRPp Back Issues Pricing:

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1994	-	$15
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Shipping: US $3 for 1 - 3 issues.
$5 for 4 issues.

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$5 for 2 - 3 issues
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$5 for 1 issue
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$15 for 3 issues
$20 for 4 issues

All funds US funds only. Make check or money order to Doug Hendricks, NOT NorCal. Send to: Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620

QRPp Subscriptions

QRPp is printed 4 times per year with Spring, Summer, Fall and Winter issues. The cost of subscriptions are as follows:

US and Canadian addresses, $15 per year, issues sent via first class mail. All DX subscriptions $20 per year, issues sent via air mail. To subscribe send your check or money order made out to Jim Cates NOT NorCal to: Jim Cates, 32412 Eastwood Rd., Sacramento, CA 95821. Subscriptions will start with the first available issue and will not be taken for more than two years. Note all articles in QRPp are copyrighted and may not be reprinted without permission of Doug Hendricks. The articles have not been tested and no guarantee of success is implied. If you build circuits from QRPp, you should use safe practices and know that you assume all risks.

QRPp, Journal of the NorCal QRP Club
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SPECIAL
84
Page
ISSUE

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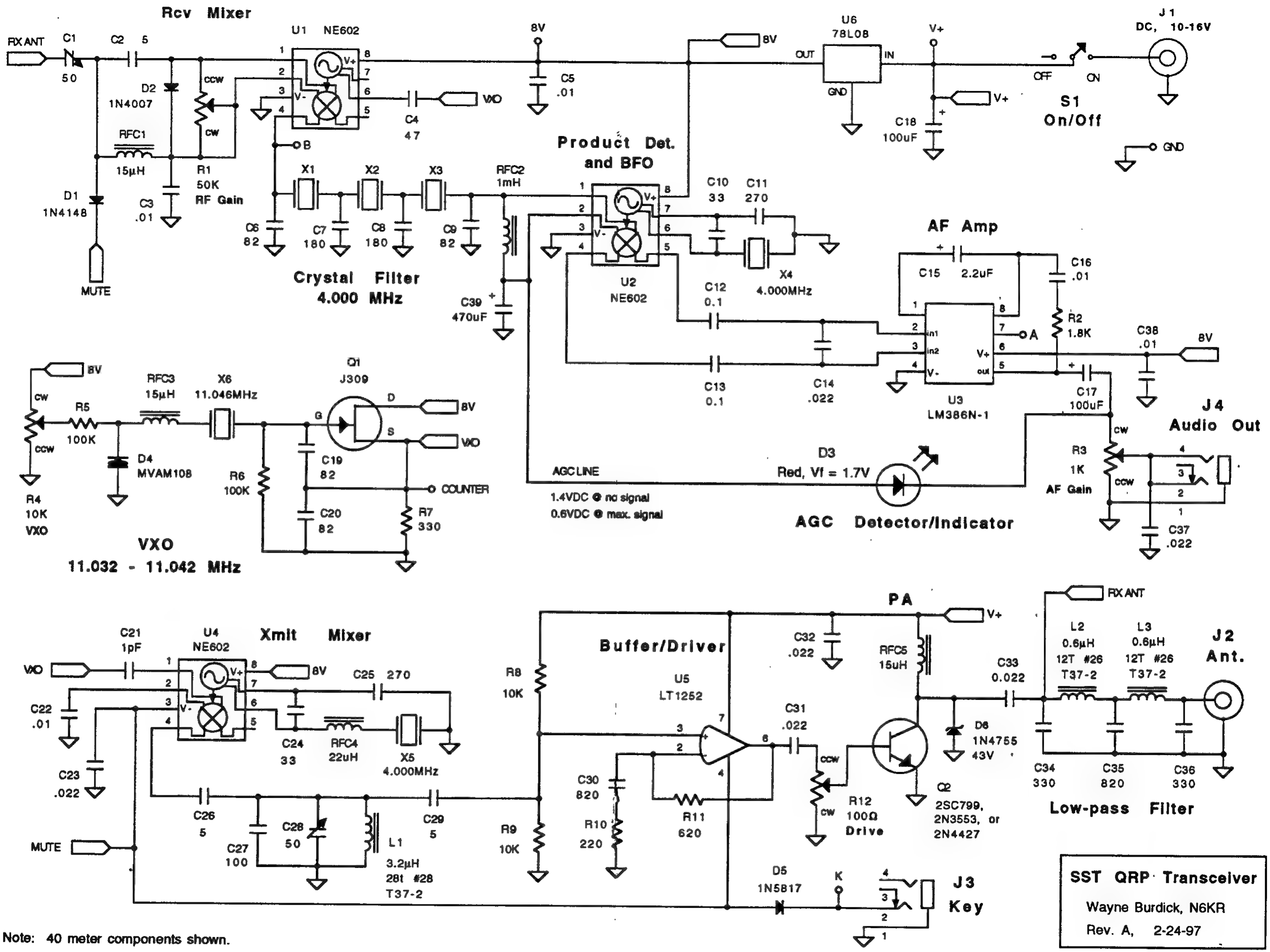
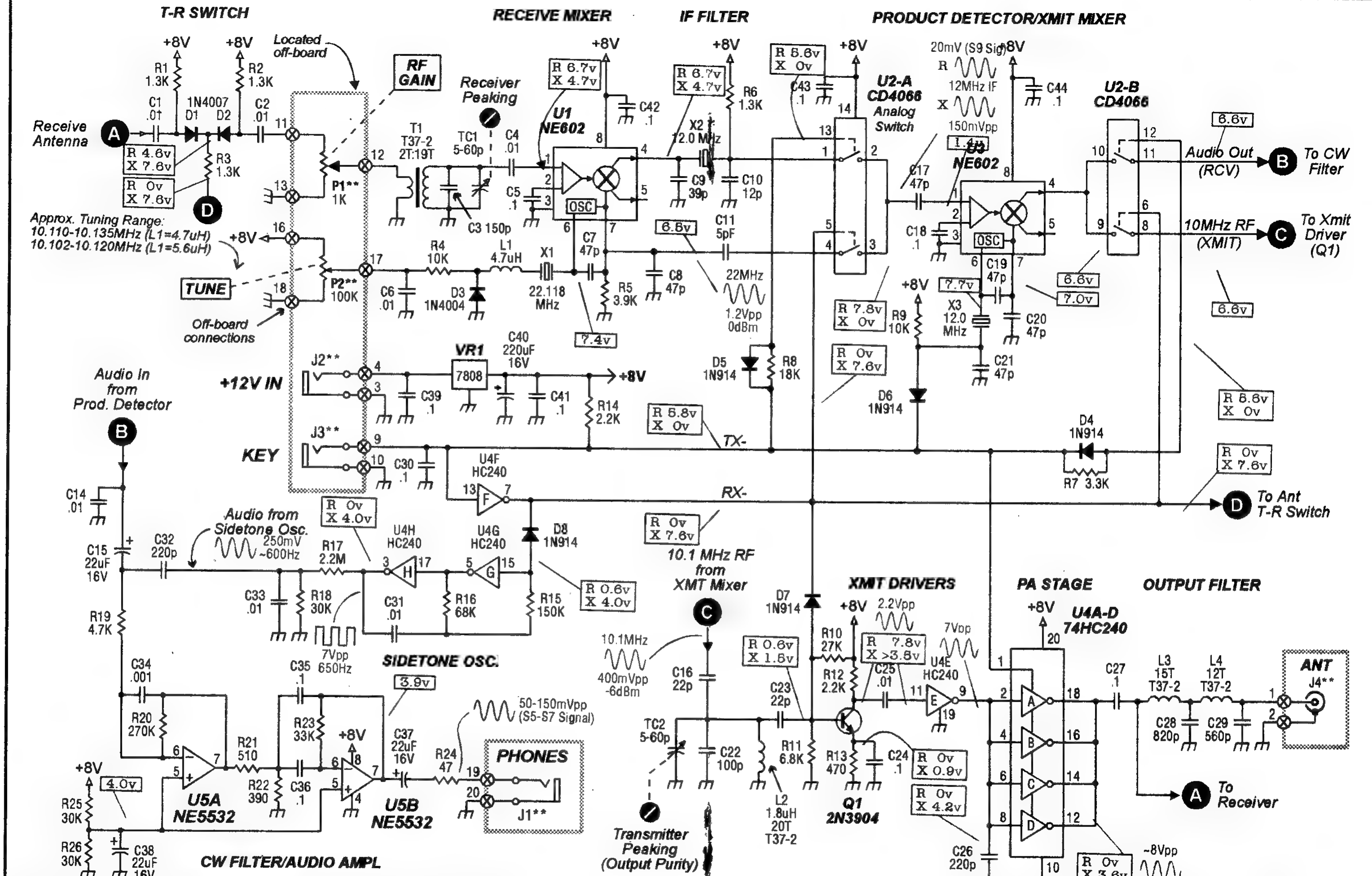


Note: 40 meter components shown.



R 0.6v → DC Volt. in RECEIVE
X 4.0v → DC Volt. in TRANSMIT
→ Oscilloscope Waveform AC Volts, peak-to-peak (x 0.32 for AC Volts rms)

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For information contact:
Jim Cates, WA6GER
3241 Eastwood Rd.
Sacramento, CA 95821

The "38 SPECIAL" QRP KIT			NORCAL QRP CLUB
30 Meter QRP Transceiver, Schematic			DRAWN BY NA5N
Designed by: Ori Mizrahi-Shalom AC6AN			APPROVED BY KI6DS
DRAWING NUMBER 38-S.SCH	DWG SIZE A	SHEET NUMBER 1 of 1	RELEASE DATE JAN. 7, 1997

QRPp

Volume V, Number 2 • Summer 1997

"This Area 51 thing just ain't what it's cracked up to be. By the way ... where's Doug?"

Journal of the Northern California QRP Club

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From the Editor

by Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620
Phone: 209.392.3522
Email: ki6ds@telis.org

Jim Cates has done it. He is my very best friend and I have enjoyed playing little tricks on Jim to give him the recognition that he deserves. The photo of Jim and part of his extensive QRP collection that was on the December 1995 cover and the copy of the QSL card that he sent his friend Idaho Mac that was in the last issue are just a couple of the examples of what I have done without Jim's knowledge.

He has told me that he would get even, but I couldn't see how, as I am the editor, and everything that goes into QRPp has to go by me. Jim got even by nominating me for the highest honor that a QRPer can have, the ARCI QRP Hall of Fame. This past Dayton, I was priviledged along with Mike Czuhajewski, WA8MCQ and Dick Pascoe, G0BPS to be inducted into the QRP Hall of Fame.

I must say that this is a tremendous honor, and one that I feel very priviledged to receive. It never occurred to me that someday I would be in the Hall of Fame with my heroes: Roy Lewallen, George Dobbs, Randy Rand, George Burt, Rick Littlefield, Wes Hayward, Doug DeMaw, Ade Weiss all have been huge influences on my career as a QRPer. Jim, thank you very much for what you have done, I appreciate it very much, and it was especially meaningful to me that you were the one who nominated me.

I also understand now what Roy Lewallen meant when he said on his induction that he felt a little strange being in the Hall of Fame without Wes Hayward being there too (Wes was inducted last year.). I strongly believe that Jim Cates deserves to be in the Hall of Fame and will campaign on his behalf. Jim is to me as Wes is to Roy. A true friend and a mentor.

Now to exciting events. Please note the announcement of the Second Annual West Coast QRP Symposium on Page 62. Jim and I are pleased that NorCal will again be able to host this event at no charge to our members. We will fly the speakers in at NorCal expense and NorCal will pay for the hotel rooms of the speakers in order to bring some of the very top names in QRP to California.

Also, note the announcement of the Ft. Tuthill QRP Forum to be held in July. Roger Hightower and all of the QRPers in Arizona are planning a great new event and I hope that you can make it to Flagstaff in July.

JoAnne and I will be traveling to England, leaving the 30th of July and returning the 18th of August. While there we plan on meeting and visiting many QRPers. We will be staying part of the time with Dick Pascoe and also part of the time with George Dobbs. There will be plenty of time for sightseeing, and both of us look forward to the trip. It will be the first trip overseas for both us and we are quite excited. Until next issue, 72, Doug, KI6DS

ERRATA: Dub Thornton, WA5YFY caught an error in the centerfold schematic in the last issue. Note on U5B the pins 1, 2 and 3 are mislabeled as 5, 6 & 7.

Tuning the T-Match in the St. Louis Tuner

by Fred Maas, K5TX

The St. Louis Tuner kit recently made available through a joint effort by NorCal and the St. Louis QRP Club is a wonderful piece of gear. The instructions on manual page 9 do not offer the best technique for tuning a T-Match. Maximum efficiency, that is, minimum loss in the tuner, is achieved when the Antenna Capacitorhas the maximum capacitance possible.

There are many settings of the two capacitors and the tapped inductor which will result in a match. To obtain the most efficient match, follow these instructions.

1. Turn the antenna capacitor fully counter clockwise (fully messhed) for maximum capacitance.
2. Turn the TX capacitor to mid scale.
3. Put the low/high capacitance switch on HIGH. The LOW capacitance switch setting will be wise and useful only on high frequencies.
4. Tune your transmitter to a clear frequency, put your keyer on high speed, and hold down the dot lever briefly while tuning. This gives you a 50% duty cycle, but a steady meter reading.
5. Rotate the inductor seeking a dip in the reflected power. When you find one, rotate the TX capacitor seeking a better dip. Complete the tuning by dipping with the antenna capacitor.
6. If no dip was obtainable rotating the TX capacitor on any inductor setting, then rotate the Antenna Capacitor clockwiseabout 45 degrees and repeat step 4.

When the antenna is matched with a low capacitance setting on the Antenna Capacitor and you switch between tuner and straight through skipping the tuner, you will notice that received signals are noticably stronger without the tuner. When the the tuner is properly matched using the highest antenna capacitance possible, you will note that received signals are the same strength with or without the tuner.

The MRX-40 Mini Receiver

by Steve Bornstein, K8IDN
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After building several Micronaut milliwatt transmitters and exploring very low power communication I took on the challenge of constructing a "companion" receiver for the Micronaut. I was also thinking of a project that the CQrp (Columbus QRP Club) could possibly kit. My final incentive was the discovery that there were ninety three licensed amateurs in my neighborhood zip code. Visions of a local mini-milliwatt net flashed through my imagination.

Design Objectives

The main design objectives for the MRX-40 were samll size and simplicity. I arbitrarily decided to limit the size of the PCB to 1" x 2". Since the receiver is intended as a companion for the crystal controlled Micronaut it's disired tuning range could be easily obtained by rubbering the crystal oscillator. To avoid using hard to find tuning capacitors I decided to use a 1N4004 diode as a varicap. The prototype receiver tunes about 2.72 kHz which is adequate for the purpose intended. To keep the size at a minimum miniature molded chokes were used for both inductors in the circuit. The circuit is very straight forward and simplicity itself. It consists of a NE-612AN oscillator/mixer chip followed by a LM-380N-8 audio amplifier. The voltage supply to

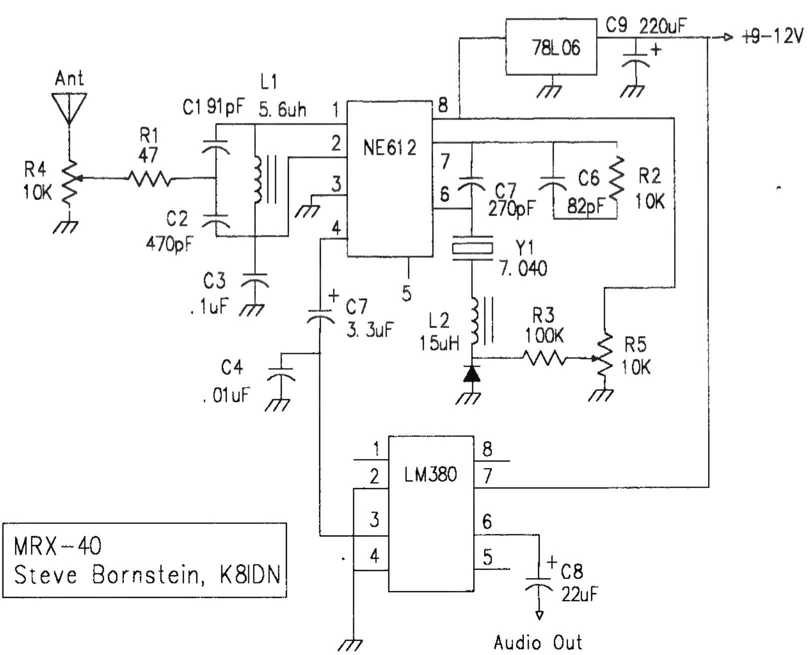
the NE-612 and tuning circuit is regulated by a 78L06 so that the 8V limit of the chip is not exceeded. Full battery voltage is applied to the LM-380. The audio output is more than ample for walkman type earphones.

A Little on PCBs

The MRX-80 can be built on a piece of perf board, but since the design was intended as a club project the layout was done on a PC using Protel's "Easytrax" and "Easypleot" software. A demo copy of this program is available on the Internet as freeware. It is quite versatile. Once the circuit board was designed and printed on paper I transfered the pattern to PCB material using TEC-200 film in a copy machine. If you have never used this product is quite handy for "one off" boards. The image placed on the film is transfered to the circuit board using a iron. The board is then etched in the conventional manner. Incidently, the "Easyplot" software besides producing a paper print of your design will also produce the files necessary for the Gerber Plotter. In our case four files were produced - Bottom Layer, Solder Mask, Overlay, and Drill Plot. With these files a PCB production facility can produce as many boards as you desire. This is how the boards for the kit version of the MRX-40 were produced. As a brief aside, if you walk into your local PCB plant with just a schematic and ask them to do the layout they charge by the hole. In the case of this project (with 62 holes) the charge for layout alone would have been about $240.

Construction

There is really nothing unusual about the actual construction of the MRX-40. You will be working in a very small area so a hobby vise comes in handy to hold the board steady wehn soldering. A good set of eyes also helps, as does a 25 watt iron with a small tip. On small boards where space is limited I find it best to mount the smallest components first. Sockets for the IC's are optional. An easy



enclosure can be made for the MRX-40 from circuit board soldered together.

Operation

Connect a 9V battery to the radio and check the output of the voltage regulator. It should be right around 6 volts. The receiver should draw about 16 to 17 mA. There is no alignment necessary for the receiver. You will find that setting the gain control to the minimum setting necessary will help keep broadcast reception to a minimum. You should be able to hear the MRX-40's oscillator on your regular receiver. Since the oscillator frequency is the same as the receive frequency you can easily check out your tuning range. I discovered that one of my Micronaut transmitters was slightly off frequency to work with the NRX-40. I shifted teh transmitter's frequency by placing a small value cap across it's crystal.

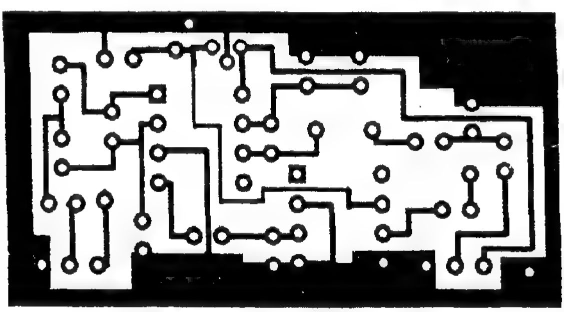
The MRX-40 is being kitted by CQrp. The kit contains all parts, PCB with mask and overlay, jacks, controls, crystal (7.040), and step-by-step manual. To order send a check for $18 pp made out to Steve Bornstein, K8IDN, 475 East North Broadway, Columbus, OH 43214.

Notes:

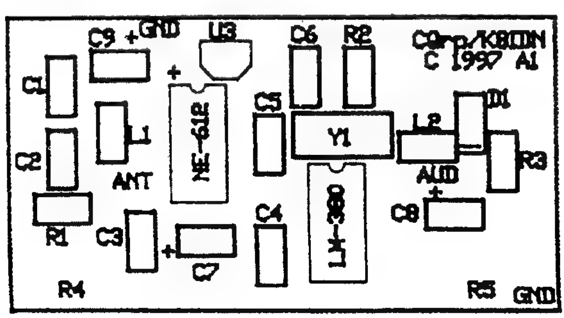
Source for the TEC-200 film: The Meadow Lake Corp., 25 Blanchard Dr., PO Box 497, Northport, NY 11768.

Micronaut Transmitter Kits are available from Dave Ingram, K4TWJ, 4941 Scenic View Dr., Birmingham, AL 35210. Price (less crystal) $15 + $2 shipping.

7.040 and 7.122 crystals are available from Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620. Price $3 each postage paid.



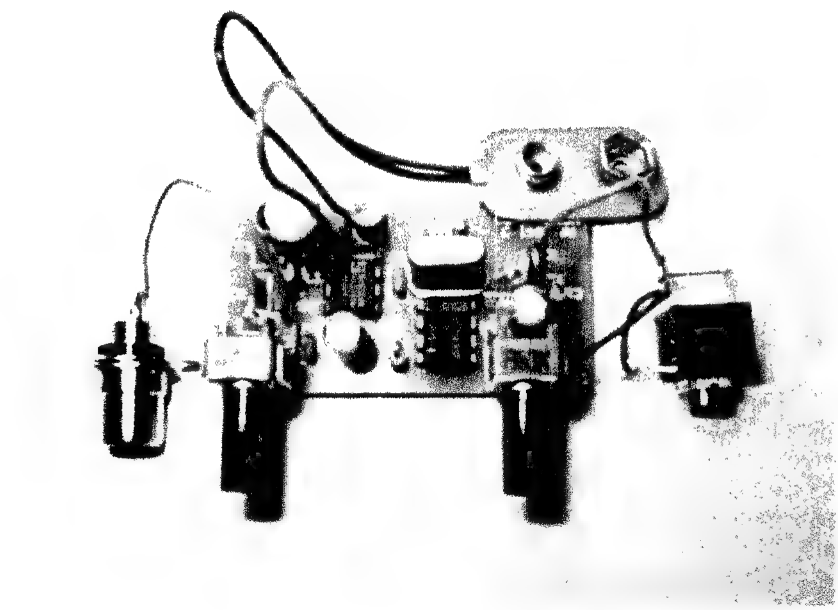
CQRP MRX-40 PC Board Pattern, Top View



CQRP MRX-40 Parts Layout

CQRP MRX-40 Parts List

R1	47ohm, 1/4W	C7	3.3/16V elec.
R2	10K, 1/4 W	C8	22/16V elec.
R3	100K, 1/4 W	C9	220/16V elec.
R4,5	10K Pot	Y1	7.040 crystal
D1	1N4004	U1	NE612AN
L1	5.6uH Molded Choke	U2	LM380N-8
L2	15uH Molded Choke	U3	78L06ACZ
C1	91pF Disc Cer.	J1	1/8" Stereo Jack
C2	470pF Disc Cer.	J2	RCA Phono Jack
C3	.1 mono cap	P1	Battery Clip
C4	.01 mon cap	PCB	Printed Circuit Board
C5	270pF mono cap	Man	Manual
C6	82pf mono cap		



Micronaut Receiver built by Doug Hendricks, KI6DS.

The PVC Gusher II

by Joe Everhart, N2CX 4-22-97
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[This article first appeared in the Oct. 96 edition of "72", the newsletter of the NE QRP Club. It has been revised and updated for publication here. Reprinted with permission from "72".]

Introduction

This article explains how to make a simple handy, single-band portable antenna for 40 through 10 meters. And, in addition, how to easily extend its usefulness for multi-band use.

The PVC Gusher II is a lightweight dipole antenna intended for portable QRP hamming. It is designed and intended for QRP Afield, QRP To The Field and the other short-duration temporary activities that are becoming increasingly popular. The Gusher II subscribes to the Spartan philosophy of reducing an antenna to the minimum necessary to do its intended job. Weighing in at less than 1.5 lbs, the Gusher is light enough to consider for backpack use and is rugged enough to give long service.

How it Came to Be

Using a dipole configuration gives repeatable effective antenna performance. Dipoles are very common radio amateur antennas because they are highly efficient and easy to build. Unlike random wires, they need no tuner for single band use. And they need no ground system to keep operating losses low. With a dipole antenna, all you have to do is raise it up in the air, connect the feedline to your rig and you're ready to go.

The dipoles we use at our home stations use heavy gauge (even hard-drawn) copper wire, low-loss heavy feedlines and insulators that look like they came from a B-grade horror flick. But for a temporary portable QRP dipole all that is overkill.

Using a dipole in an inverted vee configuration makes things simple. First of all, only a single high tree or other support is needed as opposed to needing two for a conventional dipole. When you are in a campground or field-day site, this gives you more freedom about where you can install your antenna. Not only that, but since most of the weight is supported at the center of the span, the wires don't have to be heavy gauge copper. And with QRP, insulators don't have to withstand high voltages so heavy, large ribbed ceramic or glass monsters are unnecessary.

Like many hams, I've built lots of dipoles for both home and field use. I've used "store-bought" center insulators, made my own from sheets of plastic and used an end insulator with the coax tied or taped onto it for strength. For end supported dipoles you need this. And I've run the gamut for end insulators from ceramic and glass "egg" jobs to six-inch $5 each commercial plastic multi-kv jobs. Lately, though, I've simply used a three inch piece of inexpensive pvc pipe and drilled a couple of holes in it. With low power you don't need much.

There was mention in 1995 on the Internet qrp mail list of a very simple qrp antenna, the BIC (Tm) Flamethrower. Devised by Fred Turpin - K6MDJ of the illustrious Zuni Looper group, it consisted of some lightweight speaker wire and thin coaxial cable with a sawed-apart disposable lighter body as insulators.

PVC Gusher Classic

Not to be outdone by such a flash-in-the-pan effort, I used plastic plumbing parts to make an antenna that fairly gushes with strong signals. I dubbed it the PVC Gusher. The original, the

Gusher Classic uses the same type of construction as the left-coast progenitor, but with PVC plumbing parts substituted for the sawed-apart lighter. It has so far seen print only in the manual for the NEQRP Twenty-30 mast kit.

Figure 1 shows the details. Each 1/4 wave leg of the dipole is made of 20 or 22 gauge insulated hookup wire. The center insulator is a pvc pipe end cap and the end insulators are 1/2 inch long pieces of 1/2 inch (i.d) pvc pipe. The wires are simply passed thorough small holes drilled into the insulators and knotted to secure them. The feedline, a length of small-diameter 50 ohm coax such as RG-174 or RG-122 is passed through a hole in the end of the pipe cap and soldered to the dipole wires. The pipe cap center insulator is filled with epoxy to weatherproof it and secure the coax. A cup hook is screwed into the epoxy for the support line.

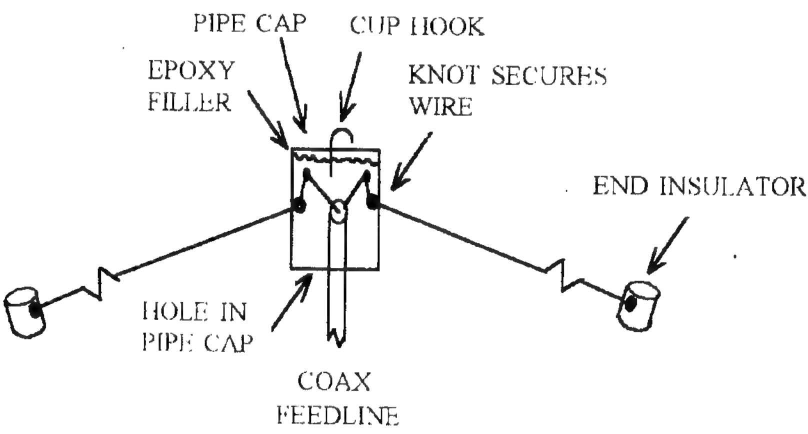


Figure 1 Gusher Classic Center Insulator

PVC Gusher II

As handy as the original Gusher was, it still had a few shortcomings. Assembling the center insulator assembly took some skill to get everything together properly. And with soldered connections inside a sealed center insulator, the antenna was useless if one of the wires happened to break at the insulator. (Murphy says this will happen!) Also, with the feedline and two legs all coming together in the center, the antenna can be a little difficult to wrap up for storage. Finally, dipole element lengths couldn't be changed to use the antenna on another band.

The Gusher II circumvents the connection shortcomings by using some simple hardware. As you can see if Figure 2, a 1/2 or 3/4 inch pipe cap forms the center insulator, but the connection methods are more sophisticated. The coaxial cable this time goes through the open end of the cap and is attached to bolts through the side of the cap with ring lugs. Perhaps I'm retentive, but I both crimp *and* solder the lugs. The bolts are held in place by hex nuts snugged down well on the outside. Dipole wires are attached to ring lugs for physical and electrical connections. Wing nuts on the bolts secure the wires and make no tools needed for installation or removal.

Insulators at the other end of the dipole are the same as with the Classic. They are 1/2 inch lengths of 1/2 inch pvc pipe holes drilled in them just large enough to pass the wire through. The

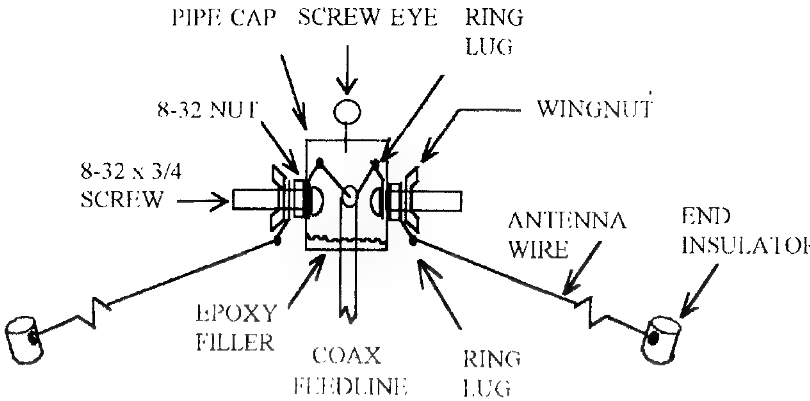


Figure 2 Gusher II Center Insulator semi-exploded view

wire is knotted to secure it.

Since the wires don't have to support the feedline weight, 20 or 22 gauge wire has adequate strength and attaching them with ring lugs is fine. Since the dipole legs are easily removed, storage is simplified. You can disconnect the legs and wrap them separately from the coax so you don't end up with a tangled mess. Not only that, but you can easily disconnect one set of dipole elements and replace them with another set for different frequency bands.

Single Band Dipole

The simplest configuration is the single band inverted vee dipole. The center of the antenna should be at a height of 20 feet or more and the ends at least 7 feet or so above ground. Each leg is a quarter wavelength long as calculated from the familiar formula L (FT) = 234/ F(MHZ). Insulation on the wires will make the dipole electrically longer by several percent, so the antenna should be cut to this length and trimmed for lowest SWR. As mentioned above, a Gusher II can be used on different frequency bands by cutting sets of elements for each band desired.

Multi-band Fan Dipole

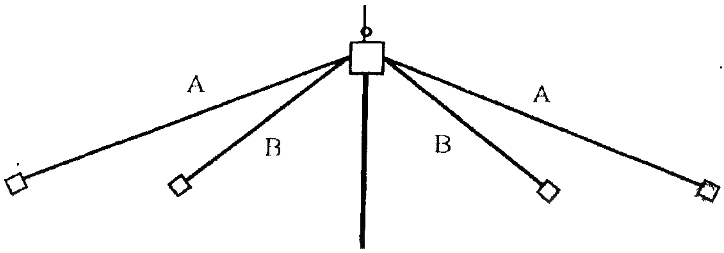
Dipole antennas have a low feedpoint impedance at their resonant frequencies and a much higher impedance elsewhere. So you can use two or more (cut for different frequencies) in parallel and feed them with a single feedline. This works because the high impedance of the "off-frequency" elements decouples them from the feedline. The "extra" elements are merely attached to the center insulator bolts along with the original elements. There is some interaction between the elements if they are spaced too closely. It's best to tie the ends off to separate supports to separate them as much as possible. See Figure 3.

Multi-band Leapfrog Dipole

Another way to make a multiband antenna is to break each leg up into sections with insulators as in Figure 4. The inner sections are cut to a quarter wavelength on the highest band, then next sections add the appropriate length for the next highest band, etc. To operate on the highest band, the inner insulators are unjumpered. Alligator clip leads are used to bridge

insulators for each successive band as desired. The antenna must be lowered to change jumpers, but this isn't too tough with an inverted vee!

Actually the Gusher-II antenna is



A = 1/4 WAVE ON BAND 1

B = 1/4 WAVE ON BAND 2

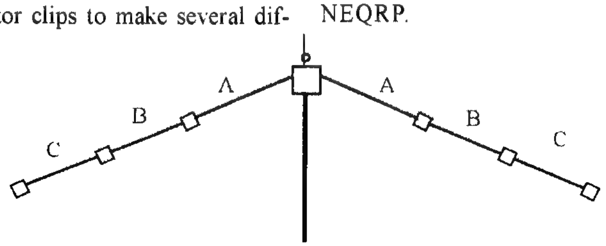
Figure 3 Gusher II Fan Dipole

even more versatile since its elements can be removed and replaced with any others that will make a coax-fed HF antenna. Some possible examples include the half-square antenna and an elevated wire ground plane vertical antenna. The next time you hear me on the air in a QRP portable operating event, ask me how *my* Gusher is set up!

The Gusher II is easy-to-build and very handy for throwing in a backpack or duffel bag for portable operation. However if you want most of the work done for you, a kit is available from N2CX. The kit includes the pre-assembled center insulator and attached 30 foot feedline with a BNC connector. Also included are two 50 foot pieces of wire, end insulators and alligator clips to make several different multi-band designs. Best of all is a 10 page manual that tells you how to make a single band dipole in 15 minutes and illustrated instructions for fan and leapfrog dipoles. The G-II kit is $30 postpaid.

The single band Gusher Classic is also available for $25.00 postpaid. It comes cut for 40 meters (actually a little long) and the included manual describes how to put it on any HF ham band from 40 through 10 meters.

Also available is the companion NEQRP Twenty-30 Portable PVC mast semi-kit. It comes complete with a 20-plus page manual and all hardware. You buy the PVC pipe locally. The mast kit is $15 postpaid and proceeds from it go to NEQRP. 72/73,



A = 1/4 WAVE ON BAND 1

A+B = 1/4 WAVE ON BAND 2

A+B+C = 1/4 WAVE ON BAND 3

Figure 4 Gusher II Leapfrog Dipole

Rainbow Tuner Application Notes

by Joe Everhart, N2CX
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Compiled by George Heron, N2APB
g.heron@dialogic.com
[Reprinted with permission from the NJ QRP Club Web Page.]
http://www.njqrp.org/

Rainbow Tuner Insertion Loss?

John KO6TS asks ...

"I noticed that the specs for the rainbow tuner say it has a 6 dB insertion loss. Why would I want to use a tuner which reduces my power by 1/4 on transmit and my received signal strength by 1/4? Perhaps I didn't quite understand something correctly. If so, somebody please straighten me out."

Joe N2CX replies: Believe it or not there is a very good reason to use a bridge with that insertion loss! While you are tuning up with the bridge in line, the loss means that no matter what SWR the bridge sees, it reflects back at worst a 2:1 SWR to the rig. This is important with many simple QRP rigs (the 40-9er is a good example) because they tend to oscillate and generally do strange things with high SWR, making them difficult to use with a tuner. A second reason is that reducing power delivered to the antenna during tuneup is a good QRP practice minimize QRM to others on the tuneup frequency.

When tuneup is complete, the loss is eliminated by switching the lossy bridge out of the feedline to bypass it! Entiende usted?

On the other hand, you *can* leave it in line if you want to reduce your signal for some reason!

Forming the Leads of a 1N34 Diode

To give best performance at low power levels, the detectors in the SWR bridge are germanium 1N34 types. They are somewhat fragile when you are bending the leads. The manual warns about their fragility, but learning how to do it is an acquired talent (That means that you might have to bust a couple before you learn how to do it!)

If you do happen to break one, you can get a replacement at your local Radio Shack. They sell them in packs of 10 for less tha $2.00

Terminal Pin Hole Sizes

We have been working with the pc board vendor trying to get the holes for the 9 external connection terminal pins just right. Early boards had holes that were a little tight. The manual tells you to press them firmly into the holes until their shoulder is flush to the board. On early boards the holes are a little tight. You can either drill them out with a No. 56 drill or just press them in as far as they will go and solder them in place. Having the shoulder on the board is not mandatory.

Recent boards may have terminal holes that are slightly oversized so the pins ar not a tight fit. In this case the best installation procedure is to put the pins into their holes and hold them in place with cellophane tape until they are soldered in place. Once soldered they stay just fine.

Can I use a Balanced Antenna?

"I am about finished building the Norcal 38 Special transceiver kit and I want to use your Rainbow Tuner kit in conjunction with it. I will some RG-174 coaxial cable from the PCB to a coaxial

connector and then I will connect the coaxial connector to the Rainbow Tuner. From the Rainbow Tuner I will run to a Hi-Q Antenna Center Insulator. From the Center Insulator I will run a balanced antenna on either side of the Center Insulator.

"I was told to use about 48 feet total of #12 stranded copper speaker wire. I will use about 2-3" of RG174 coax from the PCB to the 38 Special. I know that the SWR is critical when using QRP rigs so I am trying to configure it as accurately as possible. So each side of the balanced dipole should be about 24 feet each side. I can watch the SWR meter on the Rainbow Tuner to trim accordingly for best reading. Do you have to calibrate the tuner by some means for accuracy or is it all right as built? Will the tuner will work as outlined here with a balanced dipole antenna?"

Joe N2CX responds ...

Sorry to have to tell you this, but the Rainbow Tuner is intended to work with an end-fed half-wave single wire type antenna, not with a balanced antenna. Tuners for balanced type antennas, unfortunately, are more complicated than the simple one in the Rainbow. However the Rainbow does include an SWR bridge that will work very well with any HF antenna fed with coaxial cable.

Hamstick out a Window?

I live in a housing development that does not permit outside antennas. Would the Rainbow Tuner work with a Hamstick that I can sneak out of a second story window?

Joe N2CX responds ...

I think you may have been mis-informed about the Rainbow Tuner. Unfortunately it is not a general purpose tuner, but one intended for a specific type of antenna. General purpose (read: expensive!) tuners can be used to match a number of different type of antennas to 50 ohm coax. The Rainbow Tuner, on the other hand was designed for a specific type of antenna: the end-fed half-wave.

By designing for only one type of antennas we were able to significantly simply the circuitry. On the other hand, the SWR bridge part of the Rainbow is quite usable by itself with any HF antenna or antenna tuner fed with 50 ohm coax cable.

Dipole Antenna with Rainbow Bridge

Although this is more of a note about constructing a center-fed dipole, it also addresses use of the Rainbow Tuner.

A center-fed dipole consists of two quarter wave pieces of wire joined in the center by an insulator and connected to other insulators at the end. It has an impedance that closely matches coaxial cable, so I recommend direct connection of coax (RG-58 is fine) right at the center.

Strictly speaking the antenna is a balanced antenna and coax is unbalanced, but in practice, for non-directional antennas direct feed with coax usually works well. If you are concerned by this, you can put a balun at the feedpoint or coil up about a half-dozen turns of coax cable at the feedpoint in a coil 6 or 8 inches in diameter. I usually don't bother.

Simply connect the coax center conductor to one side of the center insulator and the shield to the other side. You should also provide some sort of strain relief for the coax at the center.

16 ga wire is fine for the dipole legs and as mentioned earlier, the length on each side of center should be a quarter wavelength. This can be easily calcualted using the formula

$$L(FT) = 234 / F (MHZ)$$

where L is the length in feet, and F, the operating frequency in megahertz. For 10.125 MHz, this works out to about 23 feet, 1 inch either side of center.

It is best to start with the antenna a little longer than calculated (6 inches or so) and measure the SWR, then trim a little at a time until the SWR is lowest at the frequency you want.

The other end of the coax cable should go to the bridge portion of the Rainbow to check SWR. It goes to the OUT and GND terminals and your transmitter goes to the IN and GND terminals. The manual shows a switch to bypass the bridge after adjustment and this is a good idea since the bridge uses up 3/4 of your power while in use.

The dipole center should be as high as you can get it. For 30 meters, at least 20 feet above ground is best. The ends can either be supported at the same height (end-supported dipole) or the center can be supported with the ends drooping (inverted Vee dipole.) For the inverted vee, the ends should be no less than 7 or 8 feet above ground. As with most antennas, the higher you put up the antenna, the better it will work.

Antennas and the Rainbow Tuner

Now that the Rainbow Tuner kits are out in the world, I've been getting frequent messages of the form "How can I use my Rainbow Tuner with my G5RV/ Hamstick/Windom, etc.?"

Unfortunately, the answer to the question is "You probably can't". You see the Rainbow Tuner is a special purpose tuner designed to be used only with a half-wave end fed wire antenna. General purpose tuners that can be used to match almost any antenna have to be much more complicated (and expensive) than the simple one in the Rainbow.

The intended application is described in the QRPp and QRP Quarterly articles presenting the Rainbow and in the descriptive material on the NJQRP web page (http://www.njqrp.org) Unfortunately, in their excitement to build a cute little kit, some folks have misunderstood that information.

The half wave antenna that the Rainbow is intended for is a very simple wire approximately one-half wave long that is simple and easy to use for portable hamming. An article in the Spring '97 issue of 72, the NEQRP newsletter, will have more info on EFHWA's (End-Fed Half-Wave Antennas). At a recent NJQRP meeting, we cut a 46 foot piece of hookup wire to length, strung it up to a convenient tree as a "sloper" and made a QRP contact between NJ and Chicago all within 15 minutes using the Rainbow Tuner.

The Rainbow's tuner circuitry is set up to transform the half-wave's high impedance down to 50 ohms and has a limited tuning range since the antenna is nearly resonant. It simply doesn't have the capability to cope with unpredictable impedances.

The Rainbow manual *does* include a section describing in general terms how you might go about reconfiguring the tuner for other antennas, but that is a matter for the experimenter.

On the other hand, the SWR bridge part of the Rainbow *is* useful with any HF antenna or tuner fed with 50 ohm coaxial cable. It operates automatically and is self-calibrating to give accurate SWR readings with HF QRP rigs in the range of about 200 mW to 5 W. And it is small enough to be built right into the case of even a rather small QRP rig.

If you have any questions about the Rainbow's capabilities or uses, please feel free to contact me.

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THUMP THOUGHTS

by Daniel C Winkler, N7IVR
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This article is a condensation of a 5 part series posted to the qrp-list earlier this year (3/27, 4/6, 4/13, 4/17, and 5/4). You can get the posts from the qrp-l archives by sending a command to < listserv@Lehigh.EDU >. Leave the subject blank or write "x". In the body of the message write "GET QRP-L/ARCHIVES/1997 970327" to get the March 27th archive.

DEFINITION OF "MR. T"

The NC 38S has a "thump" on key-up which can be quite loud. Some rigs exhibit very little thump. I christened the thump "Mr. T" because it is not a single entity, but a complex combination of transients which excite the audio filter in U5-B to produce about 6 oscillations at 580 Hz. I believe some rigs are thump-free because the transients manage to cancel at the input to the audio chain.

In this article I will discuss the causes of "Mr.T." These causes illustrate some of the pitfalls in rig design. Then I will present some mods for eliminating "Mr. T."

THE CAUSES

I investigated four transients capable of causing "Mr. T" that were identified in posts to the qrp list:

* A ground loop involving C14 (Ron Reder 3/11/97)
* U3 T/R switching by D6 (Dave Fifield 3/18/97)
* Switch signal coupling to the output of the 4066 (Fifield 2/11/97)
* Poor dynamic regulation by the 7808 (posts to me by Glen Leinweber, Stanley Wilson and Paul Harden)

In each case I breadboarded part of the 38S circuit and looked for transients with my scope. I used a function generator driving a transistor switch to simulate keying at a rapid repetitive rate (30 Hz to several kHz, depending on what was being investigated.) The load of U4 was simulated by a 100 ohm resistor. I have not investigated stray RF pickup effects. That would require a completed rig, and my board is still virgin!

THE C14 GROUND LOOP

This is a minor contributor to "Mr. T," but is noteworthy as an excellent example of a ground loop. A ground loop is a ground path shared by more than one section of a circuit. The path has finite resistance/reactance and allows unwanted feedback from one section to another. These paths can be extremely subtle and difficult to identify.

C14 (0.01uf) is the first audio filtering element. It is supposed to bypass higher frequencies to ground before they enter the high gain (about 1000) audio chain. Look carefully at the ground path for C14 on the top of the board. It is a few mm wide and after running a few cm, it encounters the ground pin (10) for U4. The audio ground path then shares the U4 ground path for several cm. Even though the path is quite wide, it has a finite resistance.

I passed a DC current from U4, pin 10, to the negative power supply connection on the board's edge. I was able to show that a 75ma current flowing in U4's ground (about what it needs for transmitting) would induce a 240mv signal at the ground end of C14 relative to C38, the audio ground reference. That 240mv transient will be amplified by U5 into a 50mv thump.

The same effect can be seen on the positive supply trace. The +8v supply at U3 and U5 will vary by about 0.5mv and 2.6mv respectively when U4 switches on

or off. U5, the NE5532, is excellent at rejecting supply fluctuations, thanks to the constant current supply to its differential amplifiers, but the NE602, U3, will cheerfully pass on supply fluctuations.

U3 / D6 TRANSMIT OFFSET

This is a big contributor to "Mr. T." U3 is both the receive product detector and the transmit mixer. During transmit, D6 conducts to bypass C21 (47pf) and shift the frequency of X3 lower (I said *higher* in Thump Thought Part 2, but it goes lower). That will raise the transmitted frequency (transmit freq = 22MHz VXO - 12MHz BFO) so that you transmit on the same frequency on which you were just listening.

When D6 is switched, it couples an 8 volt transient on X3 into U3 via the 3pf parallel capacitance of X3. In addition, the altered feedback causes the oscillations measured at pin 6 of U3 to fall from 800mv (peak-to-peak) on receive, to 400mv on transmit. The NE602 is a product detector. The output is the product of the inputs. These shifts in the local oscillator input are multiplied by the RF input from pins 1 and 2, and appear as a large transient in U3's output, causing a 2.7 VOLT (pk-pk) thump at the earphones. If you short pins 1 and 2 together, there is no output thump. You just plain get no output!

THE 4066 SWITCH

The 4066 switch has a schmidt trigger on its input. The switched channel turns on (goes from many megohms to about 85 ohms) when the switching gate voltage rises to 2.88 volts, and turns off when the gate falls to 2.70 volts. Motorola specifies their version's switching leakage current as "less than 0.1ua". This may seem inconsequential, but when looking into a 4.7k load, and followed by a voltage gain of 1000, it produces problems. On the breadboard, a 4066 switch followed by the U5 audio chain produced a thump of 2.7 VOLTS (like the U3 thump), which took 10ms to decay to the 40mv level. In my cheap WALKMAN-clone earphones, 20mv (pk-pk) produces a nice listening volume.

In his post of 2/23/97, Lee Ritchey gave some excellent guidelines for using the 4066 switch. The switched signal must be between the supply rails (between 0 and +8 volts, for the 38S), and the impedance of the switched signal should be about 1000 ohms.

THE 7808 REGULATOR

The 7808 is a robust voltage regulator, but it is not perfect. It produces some noise on its own (see Glen Leinweber's post of 2/12/97, and Mark Gaponoff's "Fried Chicken Hunt" of 3/30/97). Its dynamic regulation is also not quite up to the task of the sudden 75ma drains that U4 imposes on it. On the breadboard, it allowed a 15mv transient to appear on the power line when a 100 ohm load was switched in and out of the circuit. This transient is directly passed on by U3, and contributes to "Mr. T." Note that doubling C40 to 470uf would only halve this transient.

WHY "MR. T" IS VARIABLE

During my experiments I reached a point where I had almost all the 38S receive circuitry on the breadboard. While I was fooling around with a balanced input to U3 on the breadboard, I suddenly had a NO THUMP condition. The total peak-to-peak thump at the earphones was only 5mv. It would rise and fall from about 3 to 7mv peak in a beat with the 60 cycle noise (I was keying the breadboard at 30 Hz). I had just moved the wires from the input transformer a small amount. Further investigation revealed a "sweet spot" for connecting the input transformer, and a "just-so" placement of the wires. A quarter inch deviation would

raise the thump dramatically.

I believe what I was seeing was cancellation of several transients by subtle phase shifting of the U3 transient. Earlier I had seen the initial part of the transient change when looking at first one cause (U3) and then another (4066). Sometimes it was positive, sometimes negative. When moving the U3 balanced input transformer wires, I could watch the initial transient go from positive, to zero, to negative. The effect was quite dramatic, and I think it explains why some rigs have no "Mr. T." Their transients cancel sufficiently so as to produce little thump. Small variations in the delays within the NE602s, or within the 4066, and variations in the coupling resistors and capacitors that make up a complete rig, must sometimes produce such cancellation.

FIXING "MR. T"

I presented the causes in the order in which I investigated them, but I will discuss the cures in the order of their importance. There are two mods on the qrp-list which have been recommended and deserve mention.

The first is the addition of an FET mute switch such as the NorCal 40-niner has. See the post by Niels Jensen Kristjans on 3/22/97. He uses an FET, a10Meg resistor, a 0.01uf cap, and a diode. I am told his will not cure all thumps, probably because the time delay is not quite long enough. If you have done this mod and still have thump, try using a cap of 0.022uf or more. You need to leave the receiver mute for at least 10ms after transmitting.

The second was a thump tamer, a form of AGC, described by Steve Miller on 2/17/97. He used back-to-back diodes from the input to the output of U5-B to limit the output to +/- 0.7 volts. This mod is worth doing for the safety of your ears. One member of the NW QRP Club called CQ and had a mobile only a block away and running 100 watts answer. Ouch!

THE 4066 TRANSIENT

I believe there is only one way of curing the thump without using a second mute switch. The 4066 switch must be moved so that there is less audio gain following it. Glen Leinweber did this to his rig before I even breadboarded mine, and told me of his success.

You will need a tantalum capacitor of about 4.7uf. The audio switch needs to be moved to BETWEEN U5-A and B. U5-A gives us most of the system gain, about 47 db (voltage gain of >50). U5-B gives us audio selectivity and a voltage gain of about 16 (24db). By moving the switch to a point later in the receiver gain, the 4066 switching thump will be minimized.

MOVING THE 4066 SWITCH

First we need to feed audio to U5-A directly. On the bottom of the board is a 3/8" trace connecting the hot end of C14 to pin 11 of U2. Cut this trace. Then, on the bottom of the board, run a jumper from pin 5 of U3 (previously unused) to the hot end of C14. You'll want to do the C14 changes (below) first. Now you have continuous, unswitched audio.

Next, isolate the two switches of U2 (U2-B on the new "centerfold" schematic). Cut the trace between pins 9 and 10 of U2 (yes, there is a trace there, on the top of the board, between the pins). Cut the trace from U3 pin 4 to pin 9 of U2. It runs on the component side o. the of the board, underneath U3, emerging at the top of U3 between pins 1 and 8, runs under C44 (right under the silk-screened "C44"), turns to the right, ducks around and under C20, and then heads north to make a left turn under the upper right corner of U2. Busy little snake.

The above step also cut your mixed (10.1MHz) transmit signal. It is possible

that a switch is not needed in this line, since D7 pulls the base of Q1 to ground anyway, and the switch could be freed up for some future task. If you want to switch the 10.1 MHz signal, run a jumper from U3 pin 4 to U2 pin 9. Otherwise, bypass the switch by running the jumper from pin 4 of U3 to the C16 (22pf) lead closest to U2 (or to pin 8 of U2 - - there is a 3/8" trace connecting them on the bottom of the board. Obviously you'll need to cut this trace if you want to use that U2 switch for some other purpose).

Now run a jumper from U5 pin 7 (U5-A output) to U2 pin 9. Get a 4.7uf tantalum capacitor (value not critical, but note that the impedance level here is on the order of 500 ohms; For Xc=500 ohms, 1uf=300Hz, 2uf=150Hz, etc.). The (+) end of the tantalum cap goes to the U2 switch, pin 11. The other end goes to the top (nearest U5) of R21 (510 ohms), the input to the U5-B section. A tantalum cap has lower leakage than an electrolytic, and is less likely to self-discharge while the switch is open. If the cap has to be re-charged when the switch closes, it will cause some thump.

Next we need to separate U5-A from U5-B. To the right of U5 is R21 (510). On the component side of the board there is a trace going from R21, underneath U5, to pin 7 of U5. Cut this trace where it ducks under U5.

MOVE THE SIDETONE INJECTION

Now you have the audio switch moved, but the sidetone is gone. Glen suggested "You have to inject TX sidetone into U5b somewhere. The obvious place is the junction of R21, R22. For the TiCK sidetone, about 270k series resistor. For the HC240 sidetone, about 390k series resistor from U4, pin 3. ... You may have to play with these values somewhat." I have not breadboarded the sidetone injection, but this looks right.

You can do away with R17, R18, C33, and C32. They were there to take the sidetone level down by 50 db (the gain of U5-A).

INCREASING THE TIME DELAY

You have eliminated the 4066 thump, but U3 is still thumping away. There is no cure for the transient coming from U3, although it can be reduced. However, U3's thump can be hidden by increasing the time constant of R7/C12 (note that the new "centerfold" schematic left out C12 and C13). The stock time constant is 0.33ms (0.1uf * 3.3k). We need to increase it so that the 4066 doesn't switch for 5 to 10ms, long enough for the transients to die down. You can change either C7 or R7, or both. Changing R7 to 270k will do the trick, for a time constant of 27ms. The control gate of the CD4066 (U2) has an extremely high impedance, so 270k will be fine.

Note that the 2.88 volts needed for the 4066 switch to turn on is only 36% of 8 volts. At one time constant, the voltage on an RC network is already 63% of the final value. That is why our time constant must be much longer than the 5 to 10 ms of settling that we need.

C14, C15, AND THE C14 GROUND LOOP

At the beginning of the audio chain are C14 and C15. C15 is too large (Xc = 24 ohms at 300Hz) and C14 is too small (16k at 1000Hz). The input to the audio chain is 4.7k (R19). C14 and C15 should both should be about 0.1uf (2.7k at 600Hz). You won't notice the tiny loss in audio gain this will cause.

Ceramics are peizoelectric materials. Watch out for microphonic ceramic capacitors, when they are followed by lots of audio gain. Metalized film capacitors are a better choice for C14 and C15, although they are physically bigger.

The ground end of C14 should be

moved to the ground near C38. You will have to cut the wide (1/8") ground trace on the top of the board, running to the right from C14, underneath C15, then up under D7, to pin 10 of U4. I would cut it close to C14. Then run a jumper from the ground end of C14 to the ground near C38, the 22uf ground referencing cap for U5.

U3 POWER FILTERING

Although the power supply transient at U3 is a cause of more thump, it will be hidden by the increased time delay. However, U3 amplifies power line (+8) noise produced by the 7808. Filtering the supply to U3 will make the receiver MUCH quieter. A 220 ohm resistor and a 10uf cap will do, but a transistor "virtual inductor" is better. I first saw this circuit in Roy Lewallen's optimized QRP transceiver.

U3 gets its power via a "comb" of traces going between the pins (1 through 5) of U2, on the bottom of the board. These 4 thin traces are easily cut, isolating the power to U3. An NPN transistor (2N2222, or...) is connected with the collector to the +8 volt line, and the emitter to pin 1 of U3. The base is fed with a 10k resistor from the +8v line, and smoothed with a 1 to 10uf tantalum or electrolytic cap to ground (watch that polarity).

A similar fix can be applied to U5. Glen Leinweber described a mod to reduce the 7808 noise seen by U5 (2/12/97). He put C38 across R25 (to +8) instead of across R26 (to ground). If you are concerned about noise in the U5 audio circuit, I think a better fix would be another "virtual inductor". The power for U5 comes from a wide trace on the top of the board at the right hand side, about in the middle. Cut that trace somewhere along that right hand border, and install another NPN transistor as you did for U3. Since U5 handles large audio swings (whereas U3's drain is constant), you will also need an electrolytic cap of about 22uf from U5's power line to ground. Use the former C15.

SUPPRESSING THE U3 / D6 THUMP

My experiments showed that a balanced input to U3 greatly decreased the thump. Mark Gapanoff has added this to a working 38S, and is very pleased with the results. The mod is as follows: You will need a small torroid transformer. I recommend a FT23-43, with a 6 turn primary and a 12 turn secondary. You need at least 22uH in that secondary winding (stray capacitance will "tune" it down close to 12MHz). Remove R6 and C17. Pull up the side of C18 that goes to U3. Run a 270k (value not critical, just hundreds of k) resistor from the hole just vacated to the C18 lead you freed. This is to provide some positive bias to the primary winding, so that the 4066 switch won't be trying to pass signals at ground level.

The primary (6 turns) of your transformer goes from where the top end of C17 (closest to U2) was, to the freed end of C18. The secondary (12 turns) goes to the two holes for C17 and C18 that are close (1/16") together. Yeah, I know, you just filled that C18 hole with the 270k resistor lead. So wrap the secondary wire around the resistor lead. You ARE reading ahead before you do these mods, aren't you?

Warning: a 61-mix has a mu only one sixth that of the 43-mix. If you substitute a 61 mix torroid, you will need an FT37-61, and you will need a 10 turn primary and a 20 turn secondary. With an FT23-61 you'd need 15:30 turns, and things get a little crowded. A powdered metal (2 or 6 mix) torroid won't work at all; it just won't have enough inductance. (Actually Mark proved it can work- by capacitive coupling. He got MUCH bet-

ter results with a ferrite torroid, though.) You could, of course, tune a powdered iron torroid transformer with a variable cap...

Using a transformer for the input to U3 allows you to alter the output impedance seen by the crystal filter. Some experimentation with fewer primary turns for increased selectivity may be in order. You will also have to fuss with C12, which seems absurdly small in my opinion. My computer simulations show better selectivity when both C9 and C10 are 68pf or so, and if you change the transformer to a 3:1 ratio (for 330 ohms output for the filter), then about 150pf improves the selectivity, at the expense of increased insertion loss (up to about 8 db from 4 db in the stock configuration). You'll still only get 20 db of audio image suppression, however. Remember that the 85 ohms of the 4066 switching channel limits how far you can lower the filter's output impedance.

Warning: This transformer will inject more RF from the VXO into U3 during transmit. You only need 100mv (pk-pk), and you must not overdrive U3 (>200mv) or you will have 22MHz signal spilling over into the output. Therefore you will have to change the value of C11 from 5pf to 1pf. An alternative would be to add a cap (22pf) from U2 pin 4 to ground to act as a voltage divider.

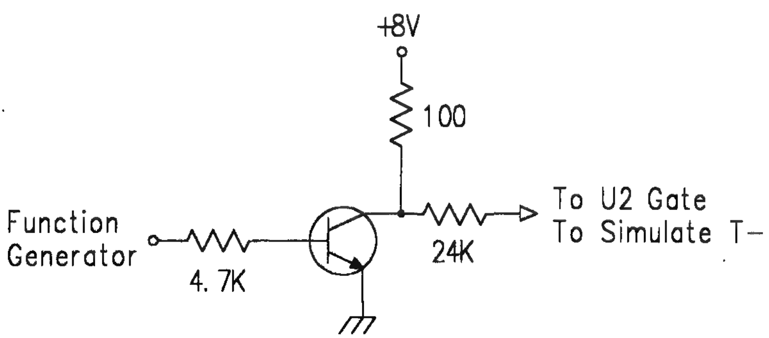
BALANCED OUTPUT FROM U3

I had hoped that a balanced output from U3 would eliminate most of U3's thump. While it did reduce the thump by about 9 db on my breadboard, the required modification to the 38S board is so extensive that I felt it wasn't justified, especially when the thump could be hidden with relative ease. However, I think that in general it is worth the extra parts to use balanced inputs and outputs in designs using the NE602.

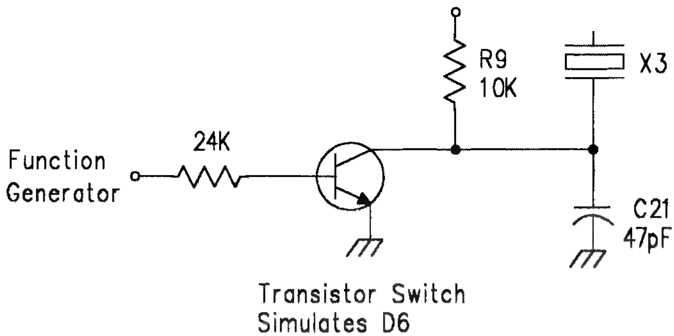
THANKS

Thanks are due all those who shared their experiences with the 38S on the qrp-list. Special thanks are due Ori and the gang for providing us all with a great rig to play with. I'm GLAD it wasn't perfect "out of the box". I would never have learned so much from just another boring old kit.

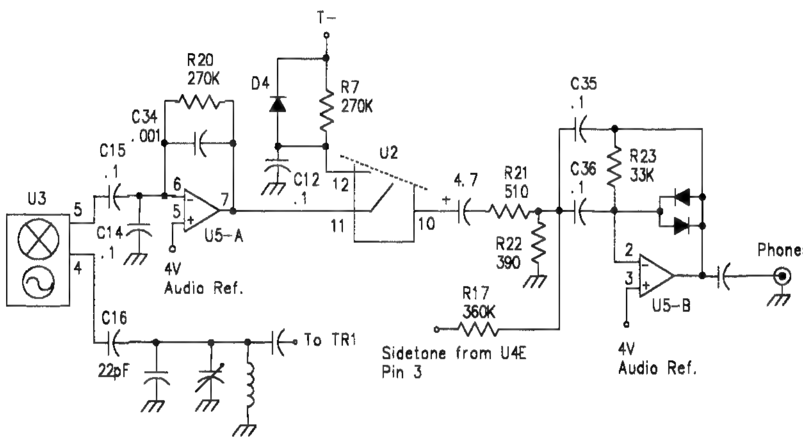
Dan Winkler N7IVR May 11, 1997



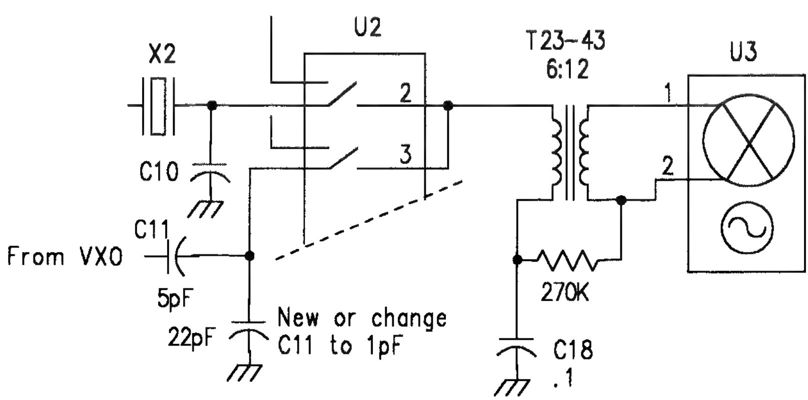
Breadboard Simulation of U4's Load



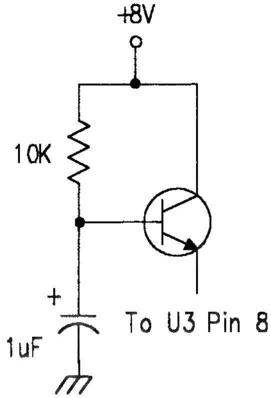
U3/D6 Switching Simulation



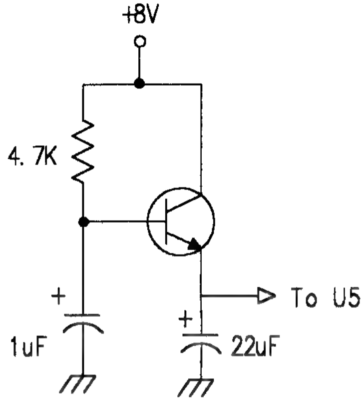
New Audio Lineup



U3 Balanced Input



U3 Power Filtering



U5 Power Filtering

Adventure Radio Society and Flight of the Bumblebees

by Russ Carpenter, AA7QU
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Adventure Radio Society is an organization of about 250 amateur radio operators from all parts of America and a number of foreign countries. We occupy a niche that we believe is unique in amateur radio.

Our Mission:

ARS combines amateur radio with a love for the outdoors. We encourage the design of radio equipment and antennas for portability and the outdoor environment. We sponsor outdoor events in which operators hike, bike, ski and boat to their operating sites. ARS promotes an operating ethic based on simplicity, respect for the environment and adherence to sound amateur practice. We offer cooperation and good will to other amateur radio organizations. We energetically use the Internet to improve the speed and quality of communications, strengthen our community, and reduce our expenses.

Our Activities:

ARS sponsors these activities.

The Spartan Sprints: Two hour sprints held on the first Monday of each month. Our scoring system encourages the use of lightweight, outdoor-oriented gear.

The Flight of the Bumblebees: A four hour sprint held on the last Sunday of each July. Home-based operators stalk approximately 50 Bumblebees located across the country, who have reached their sites by human power; hiking, biking and boating.

The Trail Friendly Radio Challenge: An on-going challenge in which participants submit designs and working models of radio gear and antennas designed for outdoor settings. Text and photographs are published on the ARS web site.

WAS/PQ: A worked all states award for operators who have contacted all 50 sites from outdoor sites thy reach by human power.

The Way We Do Business: We try hard to be progressive in the way we manage our affairs. For example, we've developed an automated emailing system,

allowing us to get in touch with our members on a regular basis. This system makes ARS an uncommonly participative organization. ARS also has a web site with pleasing design and solid content, including an automated system for reporting contest results through the web site. We publish the results of our contests on the Internet within 3 days from each contest's date.

How To Reach Us: You may become a member of ARS by emailing Richard Fisher, KI6SN, at KI6SN@juno.com. Membership in ARS is free. Contest inquires may be addressed to Russ Carpenter, AA7QU, at russ@natworld.com. You will find our web site at www.natworld.com/ars.

Rules for the 1997 Flight of the Bumblebees:

Taking Place on July 27, 1997

1. This is a four hour event, running from 10:00 PDT/11:00 MDT/12:00 CDT/1:00 EDT to 2:00 PDT/3:00 MDT/4:00 CDT/5:00 EDT. Thus, the hours of operation accommodate all four time zones. No matter where you live, there is time to for the Bumblebees to travel to their sites, set up their stations, operate the contest, and travel back to their cars.

2. Both home-based and portable operations are encouraged. Those who walk, bike or boat to their sites are Bumblebees and sign /BB. The distance travelled to the site is at the Bumblebee's discretion.

3. Maximum power is five watts. We operate CW on 40, 20, 15 and 10 meters, on the standard QRP frequencies of 7,040, 14,060, 21,060 and 28,060 KHz. We want this to be a national contest, so we encourage long-range contacts by giving double points for 20, 15 and 10 meters. 40 meter contacts receive one point. The same station may be worked on different bands for additional QSO points and multipliers.

4. Any station operating the contest may contact any other participating station, whether that station is a Bumblebee or a home-based station. Any station may call CQ.

5. Contacts with Bumblebees generate a 3X multiplier. So your score equals QSO points times (number of Bumblebees times three). Here is an example. If you make 20 contacts on 40 meters and 30 contacts on the higher bands, and make a total of 25 Bumblebee contacts, your score is (20+60) X (25 X 3), or 6,000.

5. The exchange is RST, state/province/country, and your first name.

6. Separate but equal prizes are awarded to the home-based and Bumblebee winners.

7. Participants may submit paper logs, with a two week deadline. Or participants may choose to use the ARS automated contest reporting system on the ARS web site. Results are posted during the third week of August on the QRP-L Internet Group, the ARS web site, and the ARS membership emailing system. For those who send us SASEs, we mail a paper copy of the results.

8. Russ Carpenter, AA7QU, is the Contest Manager. Mail paper logs to him at 47227 Goodpasture Road, Vida, OR 97488. You can reach Russ in the following ways:

- By mail, at the foregoing address
- By phone, at (541) 896-0263
- By fax, at (541) 896-0310
- By email, at russ@natworld.com
- By the automated email system and/or the automated contest report system located within the ARS web site at http://www.natworld.com/ars.

Roster of the 1997 Bumblebees

Lorraine	Aubert	AC6XK	1
Cam	Hartford	N6GA	2
Russ	Carpenter	AA7QU	3
Bill	Jones	KD7S	4
Bob	Cutter	KIOG	5

John	Evans	N3QOO	6
Randy	Foltz	AB7TK	7
Jeff	McDowell	N0WCF	8
Chuck	Adams	K5FO	9
Jim	Robertson	K7KBD	10
Don	Bullard	WA4IML	11
Dave	Perry	N0IBT	12
Dan	Presley	N7CQR	13
John	Cumming	VE3JC	14
Dean	Marzocca	N2TNN	15
Richard	Fisher	KI6SN	16
Dave	Benson	NN1G	17
Joe	Gervais	AB7TT	18
Richard	Arland	K7SZ	19
Walt	Windish	KB2JE	20
Richard	Overmeyer	KF6CTA	21
Kent	Torell	AB7OA	22
Rick	Tavan	N7TN	23
Brad	Bradfield	WB0CGH	24
Wayne	Burdick	N6KR	25
Sean	Lyon	AA1MY	26
Jack	Bryant	W5TFB	27
Mike	Burger	AH7R	28
Bob	Edwards	W4ED	29
Doc	Lindsey	K0EVZ	30
Mark	Adams	N2VPK	31
Dan	Wolfe	N4ROA	32
John	Elder	KD6TS	33
Bruce	Muscolino	W6TOY	34
David	Yarnes	W7AQK	35
Eric	McFadden	WD8RIF	36
Dale	Anderson	KB0VCC	37
Dick	Schneider	AB0CD	38
Joel	Malman	WA1QVM	39
Grover	Cleveland	K7TP	40
Wayne	Robertson	K4WK	41
John	Hirsch	W7RFM	42
Tony	Colaguori	W2GUM	43
Bill	Boose	N3WST	44
John	Sielke	N4JS	45
Ed	Manuel	N5EM	46
Dave	Cary	KG0ZT	47
Randy	Hargenrader	WJ4P	48
Paul	Stroud	AA4XX	49
Don	Wilber	WD6GYJ	50

The "Bumblebee" Backpacking Station

by Bill Jones - KD7S
83 Redwood Ave.
Sanger, CA 93657

In early April, Russ Carpenter, AA7QU announced details of the Adventure Radio Society's "Flight of the Bumblebee" activity slated to be held July 27th. While similar in many respects to the popular QRP-L foxhunts, this event is designed to be more of an outdoor exercise. A volunteer cadre of "bumblebees" will hike, boat or bicycle to a remote location, set up a station and provide bonus contacts for participants in this four-hour sprint.

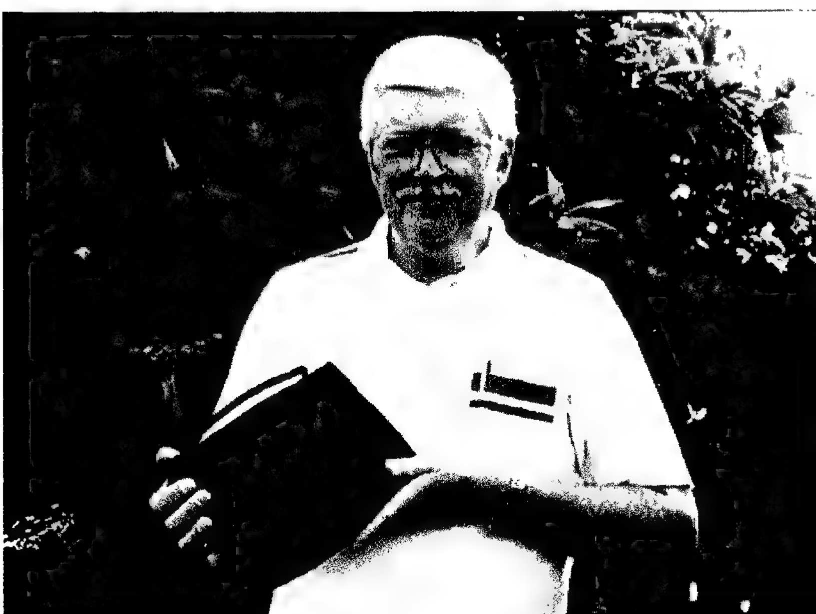
Shortly after I volunteered to be a bumblebee, I realized that most of my portable QRP equipment was much too big and clunky for backpacking. As a result I set out to create a self-contained station that was light weight, power thrifty, reliable and small enough to be tucked away in the corner of a backpack.

I chose my scratch-built NE40-40 transceiver as the foundation for the station. The 40-40 board measured 3" X 4" and weighed practically nothing by itself. Despite its size, the rig puts out 1-1.5 watts when powered by an 8-pack of fresh alkaline AA cells. I built the smallest enclosure possible for the board from scraps of ABS plastic sheet. All the controls and connectors were mounted on the front cover of the case for easy viewing with the rig sitting on the ground. As an experiment I dispensed with the conventional 270 degree potentiometer as the main tuning element and substituted a two-inch throw slide pot instead. It turned out to be a very good choice. Tuning is smooth, easy and accurate.

With the transceiver itself up and running I turned my attention to the keyer. An external keyer was out of the question due to size and weight constraints. I opted to build a keyer inside the transceiver case using an Imbedded Research TiCK-1 keyer chip. Because of the small number of additional parts needed I was able to construct the whole circuit on a scrap of PC board barely one inch square. A push-button switch was mounted on the transceiver's front panel to activate the telemetry commands. A set of Whiterook iambic paddles rounded out the keying system.

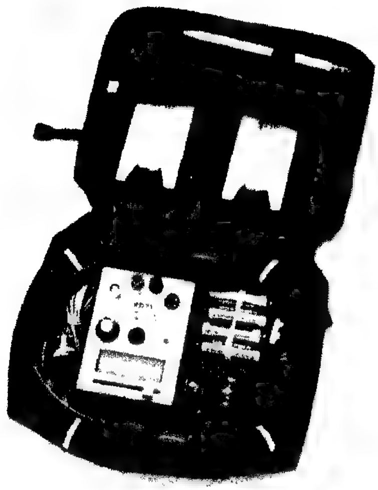
Next I focused my attention on the antenna system. This turned out to be the most challenging part of the entire station. A compromise antenna - or one requiring a transmatch - was unacceptable. I wanted a full sized, coax fed, resonant dipole. To keep the weight at a minimum I chose to build it out of #24 stranded copper wire. I made my own center and end insulators from more scraps of ABS plastic. The end insulators double as wind-up spools for the wire. I considered using RG-174 coaxial cable for the feedline but the losses, even at 7 MHZ, were more than what I was willing to accept. I opted for RG-58/U even though it was heavier and bulkier than the small cable.

Once the station components were in place, I began thinking about a suitable carrying case. While browsing the shelves of a local discount book seller, I spied a zippered book holder made of heavy duty canvas. The inside measurements were 6" x 9" by 2 ½" and with a bit of creative packaging, I determined that everything would fit inside. An added feature of the bag was the zippered outside pocket which was just the right size to hold a compact log book and a couple pencils.



Bill Jones, KD7S, holding the "Bumblebee" station in its black, zippered case.

Building this station was an exercise in miniaturization. While the rig doesn't represent the ultimate in hi-tech equipment, it has provided many solid contacts from coast to coast. It's also very nice to have a self-contained rig that will fit in the corner of a picnic basket or briefcase and is ready to go at a moment's notice. You can hear the station on July 27th signing KD7S/BB.



Inside this zippered canvas book bag is a complete 40-meter CW station. It contains a 1 watt transceiver with built-in keyer, battery pack, paddles, headphones, full sized 40 dipole, 35 feet of RG-58/U coax, 100 feet of antenna support rope, logbook, connecting cables and a pencil.

Close-up of the transceiver. Note the use of a slidepot for tuning. At the time the photo was taken the dial calibration marks had not been completed. The support legs on the back of the cabinet are removable and made from an old desk calendar.

OSCILLOSCOPES (Part 1)

Paul Harden, NA5N
P.O. Box 757
Socorro, NM 87801
NA5N@Rt66.com

When in the course of human events, it becomes neccessary to look at neat signals floating around your QRP rig, you go to a hamfest and buy that $50 o-scope. Now what? This two part article will attempt to explain basically how an oscilloscope works, operator functions, basic measurements, and some advanced applications. An o-scope is a powerful tool in any shack that can be very useful, even if a real "cheapie" with limited bandwidth.

A block diagram of a typical o-scope is shown in Fig. 1. The test probe usually plugs into the scope via a BNC connector, then passes through the switch to determine whether the input signal will be dc or ac coupled (to remove any dc component). Often this switch will also have a "ground" position for setting the zero-volts reference. Next is the input attenuators. The vertical input amplifier is quite sensitive, designed for 20-50mV of input. For larger input voltages, the signal is applied to attenuators comprised of simple voltage dividers. This is the first area of concern for cheap o-scopes, as the input attenuators may not be very linear or accurate. For example, if you appy a 10Vpp signal on the 10v/division setting, the signal should be 1 division high. Switching to 1v/div., the signal should be 10 divisions (usually full-scale) high. If it is not exactly 10 divisions, the attenuator for that setting needs adjusting. Some scopes have internal adjustments for fine-tuning each attenuator setting.

Following the attenuators, the signal is applied to the first vertical amplifier, which converts it to a differential signal. This differential signal is amplified up to high voltages which is applied to the oscilloscope tube for deflecting the beam up and down (that is, in the vertical axis).

The sweep generator is usually a constant current source charging a capacitor to make a sawtooth waveform that eventually deflects the beam in the horizontal axis. The frequency

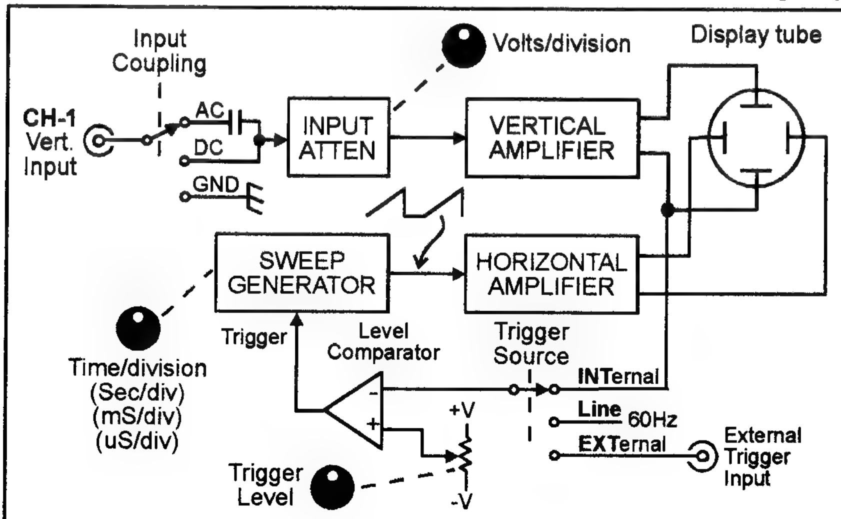


FIG. 1 - Basic block diagram of an Oscilloscpe

of the sawtooth determines how fast the beam travels from the left to the right side of the tube, and is controlled by the sweep control, usually calibrated in seconds, milli-seconds or micro-seconds per division. This is the second area of concern for an oscilloscope ... how linear the sawtooth waveform is generated. For example, a sawtooth with a nonlinear ramp will cause the signal displayed in the central portion of the tube to be expanded or compressed compared to the signal at the ends.

The sawtooth ramp is amplified to high voltages, applied to the oscope tube, to deflect the beam from left to right. An important task of an oscope is when the horizontal deflection begins. Normally a switch labeled "Trigger Source" determines what initiates the sawtooth ramp. In the "Internal" position, a sample of the input signal (in the vertical amplifiers) is sampled, with a variable resistor setting the level. When the input signal exceeds the "Trigger Level," a pulse is generated to start the sawtooth ramp and hence the horizontal sweep. The purpose of triggering is to keep the input waveform synchronized to the sweep so it appears stationary on each sweep. The trigger source usually has a "Line" position, which simply triggers the sweep off of 60Hz from the power supply. This synchronizes the sweep to the AC power frequency and is useful for checking television signals, which are synchronized to the power mains. Also, an "External" position may be present, which connects an external input signal (via a BNC connector) to trigger the sweep generator.

Other features your oscope may have are two vertical channels for dual trace operation, various modes to display both waveforms (alternate, chopped, A+B added, etc.), delayed sweep features, dual sweep time bases, built in calibrators, etc. These are all nice features, but even with these scopes, the basic scope block diagram remains the same.

Calibrating Your Scope.

The first thing you should do upon acquiring an o-scope is to check its calibration.

The vertical amplfiers can be checked with a known voltage source or 9v transistor radio battery. Measure the output voltage of the battery with an accurate voltmeter. Let's say it just happens to be +9v exactly. Set the input coupling to ground (0v) and move the trace to the bottom division. Switch the input coupling to DC and set the attenuators to 1v/div. The deflection should be 9 divisions. Switching to 10v/div., deflection should be 0.9 divisions. Internal to the oscope (or perhaps accessible from the outside) are adjustments for the vertical amplifier gain. Adjust this for 9 divisions of deflection in the 1v/div. range. Procedure can be repeated with a 1.5v flashlight battery.

The horizontal amplifiers should be checked/calibrated using a signal generator. For example, a 1MHz signal has a period of 1uS. Setting the sweep rate to 1.0uS/div., a 1MHz signal should take exactly 1 division per cycle. Set the horizontal width control properly to ensure the beam starts at the first division and ends at the last division. If the sweep rate appears incorrect, an internal adjustment (Sweep gain or similar) can be set for proper display of the test signal.

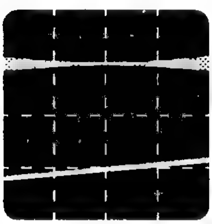
The main operator controls are:

- **Intensity** - controls the brightness of the beam.
- **Focus** - adjusts the beam for the thinnest and sharpest display.
- **VERT & HOR Position** - controls the vertical and horizontal position of the display respectively
- **VERT V/div** - controls the veritcal sensitivity of the display, i.e., how many volts (or mV) per division.
- **HOR Sweep Speed** - sets the horizontal sensitivity, i.e., how many mS or uS per division.
- **VERT & HOR vernier** - allows the vertical and horizontal sensitivity settings to be varied in small steps.

Other adjustments you may find on your scope are:

Astigmatism - With the scope intensity and focus properly set, this adjustment compensates for the curvature of the CRT tube by making it in-focus across the sweep. If your trace is out-of-focus in certain areas but in-focus elsewhere, the astigmatism needs to be adjusted.

Trace Rotation - is a small coil around the CRT that skews the trace to ensure it is perfectly horizontal. On scopes without this adjustment, the trace is leveled by physically rotating the CRT to align the trace to the graticle grid.



← Effects of **ASTIGMATISM** (Inconsistent focus)

← Effects of **TRACE ROTATION** (Trace not level)

DC BAL (DC Balance) - is a dc offset in the vertical amplifiers that causes a shift in the trace baseline when changing vertical scales. It is most obvious when measuring ac voltages. For example, you are displaying a 10Vpp sine wave, centered on the center graticle, at 2v/div. Changing to 5v/div, the sine wave shifts off the center graticle ... that is, it assumes a dc bias error. The DC BAL is adjusted until the shift no longer occurs when changing vertical scales.

HV ADJ. - is the high voltage that controls the intensity of the trace. Turn up the **Intensity** control to its brightest position, then adjust the HV ADJ for a trace slightly brighter than normal intensity. The **Intensity** control now has the proper range. The HV ADJ might have to be re- adjusted to acquire proper focus.

Very bright trace displays can cause permanent damage to the CRT, particularly on a well-used scope.

LET'S MAKE SOME MEASUREMENTS

It is assumed you have your scope relatively calibrated and familiar with the front panel controls. The sample o-scope displays are based on four vertical and horizontal divisions on the CRT screen, typical to most oscilloscopes. Some of the following examples are based on the NorCal *38-Special* kit, but applicable to similar circuits in most QRP rigs.

DC Voltages.
Say you want to check the T-R switch in your *38-Special* QRP rig, shown in **Fig. 2.** The key line is the input to the HCT240 inverter to form the 0v *TX-* on key-down and the 0v *RX-* on key- up. This will switch the rig between xmit and receive (T-R Switch).

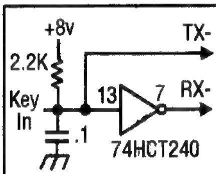
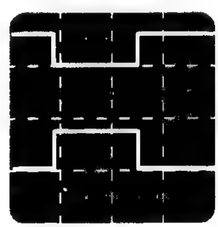


Fig. 2 - 38-Special T-R Switch

Place the scope lead on pin 13 at 10v/div. and you should see the waveform like the top trace shown ... about +6v on key-up and 0v on key down.



VERT: 10v/div DC
HOR: 500mS/div

Move the scope lead to pin 7 and you should see 0v on key-up and about +8v on key-down (bottom trace). If the output does not go "HI" (+8v) on key-down, or does not go to a solid "LO" (<1v) on key-up, the inverter is not working properly. (Its busticated).

While this test could be done with a DVM, the integration time is slow, requiring long key-downs to get the voltages. A scope will also show you how clean the switching is, or if there is an ac voltage (or RF noise) riding on the T-R voltage.

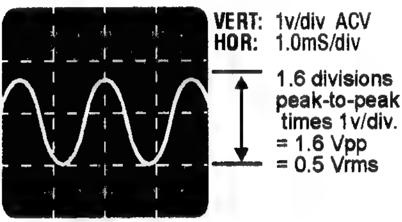
Scopes are thus good dc voltmeters, with about a 5% reading accuracy.

AC Voltages.

Here is where an o-scope pays for itself by making AC voltage (and frequency) measurements. You must remember, that AC voltages are displayed on a scope as ***peak-to-peak*** voltages, while a voltmeter measures in ***rms***. RMS voltages are about 1/3 the p-p voltage read on a scope, or specifically:

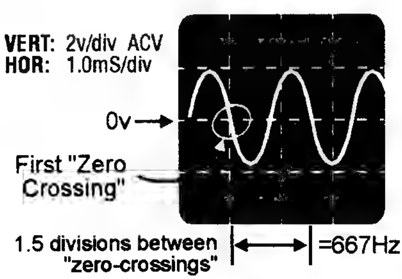
$$V_{rms} = \tfrac{1}{2}(.637 \times V_{pp}) = 0.318 \times V_{pp}$$

For example, let's measure the output voltage and frequency from the sidetone oscillator in your QRP rig. Place the scope lead on the audio amplifier output (U5-7 in the *38-S*). On key-down, you get the waveform shown below. The transmit sidetone audio is 1.6Vpp (0.5Vrms).



AC Frequency Measurement.

With this waveform, we might as well see what frequency our sidetone or transmit-offset frequency is. Most operators prefer the sidetone to be about 700Hz, while the *38-S* is designed for 650Hz. Trigger the scope for a stable waveform and set the time-base (sweep) to display 2 or 3 cycles, as shown below. Center the waveform between two horizontal divisions so zero volts on the waveform is on a graticle line, then move the ***horizontal position*** so the first "zero- crossing" is also on a division line.



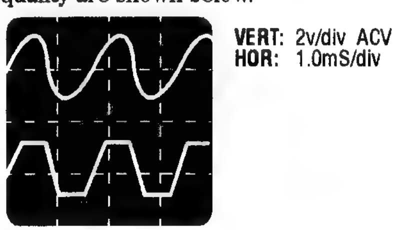
Measure the time it takes to make one complete sine wave from one zero-crossing to the next. In this example, it is 1.5 divisions, at 1mS per division, is 1.5mS. Frequency is simply the reciprocal of time, such that the sidetone frequency is:

$$f = \frac{1}{t} = \frac{1}{1.5\text{mS}} = 667\text{ Hz}$$

For the *38-S*, this is just about right. On other QRP rigs, this may be a little low to your liking. To raise it to 700Hz, calculate the time period of 700Hz (1/700 = 1.4mS). At 1.0mS/div, you can adjust your sidetone or transmit offset until zero-crossings for a single sinewave is 1.4 divisions. This will be 700 Hz. (Sidetone is not adjustable on the *38-S*).

All frequency measurements are made in this fashion, by measuring the distance between zero-crossings (or from one peak to the next) and converting the time period to frequency. This should emphasize the importance of ensuring your sweep speed is calibrated; any error in the time base will cause a corresponding error in the accuracy of your time or frequency measurements.

Quality of the waveform is another feature of a scope that is unsurpassed, since you are "seeing" the waveform in real time. Two examples of waveform quality are shown below.



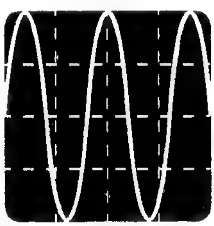
The top trace shows the sidetone frequency with distortion, perhaps due to improper time-constant on the coupling capacitors or improperly biased audio amplifiers. The bottom trace would be a raspy sounding side tone, due to the amplifier being overdriven and in compression (clipping). The o-scope is an invaluable tool for detecting and diagnosing such impurities in the signal quality.

More Nifty Measurements

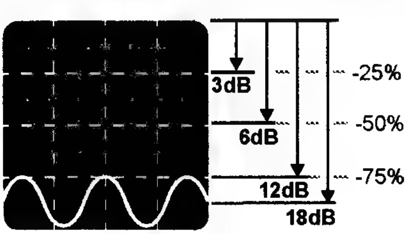
Amplifier Gain.

The gain of an amplifier can be measured in terms of *voltage* or *decibels (dB)*. For **voltage gain**, it is simply Vout/Vin of the amplifier. For example, if the input is 1Vpp and the output is 4Vpp, then the amplifier has a *voltage* gain of 4.

Gain in dB is often more useful and is how the gains of amplifiers are usually expressed. With dB's, every-time you *double* the AC voltage, you *add 6dB* of gain. It is the *ratio* of output to the input, and this ratio is easy to measure on a scope.



It is often easier to start with the output. Set the vertical amplifier gain to display the amplifier output as a full-scale signal as shown. Now move the scope probe to the amplifier input without disturbing the scope gain. You will of course have a much smaller signal, and the ratio of the input to the output will be the gain in dB. In our example of using four divisions for full-scale, then two divisions would be 6db, 3 divisions 12dB, etc. as shown below. Some scope graticles have the dB values along the side. If not, you may wish to add your own to remind you of this relationship. Note: this is *voltage gain* (Av=20log x Vout/Vin). In this example with 4Vpp output and 1Vpp input (Av=4), then the gain is dB=20log(4) = 20(0.602) = 12dB, or as shown directly on the CRT tube. Since this is a *relative* measurement, the absolute Vin or Vout voltage does not need to be determined.



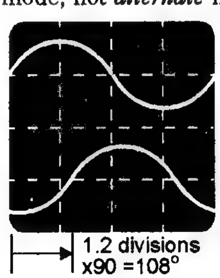
Insertion Loss.

In some circuits, such as filters or attenuators, the *loss* in the circuit needs to be expressed in dB, and is called the *insertion loss.* It is determined in the same way as amplifier gain just presented, except start with the input (the highest AC voltage) as the full-scale or reference display, then measure the output AC voltage (the lowest level). The ratio is the insertion loss in dB.

For example, with a signal generator connected to your QRP rig, you want to measure the insertion loss through the IF crystal filter. At the filter input, you can just barely squeek out 2 divisions of input signal on your scope at its most sensitive setting. (Perhaps due to exceeding the scope's bandwidth). The output from the crystal filter is 1.5 divisions (25% reduction). The insertion loss would be 3dB. If the output were only one division (50% reduction), the insertion loss would be 6dB.

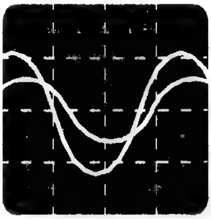
Measuring Phase Shifts.

Phase relationships between two signals at the same frequency can be measured with 2-5^o accuracy with a scope, although more suited for a dual-trace scope. The reference signal is applied to CH. 1 and the signal to be measured to CH. 2. For proper phase measurements, ensure your dual trace display is in the *chopped* mode, not *alternate* mode.



There are many methods to do this. One is to stretch out the signal so it takes 4 divisions, so each division is 90^o of phase. By measuring from a common point on one signal to the next (zero-crossing or from peak-to-peak), the phase can be measured. For example, say you are making a phased-array antenna in which one feedline must cause a 90^o delay. You calculate the electrical length for a ¼λ [L=(246/f) x Velocity Factor] and cut

the coax to that length. You are now working on blind faith that you have exactly 90°. With a scope, you can measure it fairly accurately by injecting a signal into one end with a signal generator (at the frequency of interest) and a 50Ω load on the other. Connect the scope CH.1 to the coax input and CH.2 to the load end and measure the phase. The CH.2 signal is delayed by 1.2 divisions, at 90°/div is 108°. (See illustration on previous page). Your delay line is too long. Cut off an inch or two at a time until the CH.2 signal is 90° from CH.1 for precise tuning of the delay line.

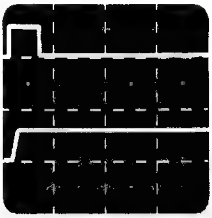


Another method is to superimpose the two signals on top of eachother. Make one signal larger than the other so you know which one is what. In the example shown here, the smaller signal *lags* the larger signal by about 45°, estimated by where they cross. For more accurate determination, use the time base to measure the time period of one cycle (T1), then the time period one signal lags (or leads) the other (T2). The phase shift is then $\theta=(T2/T1)\times 360°$.

Phase measurements can be made on a single trace scope as well. First, connect the reference signal via a BNC "T" to both the ***external trigger*** and the normal vertical input and adjust the ***trigger level*** so the zero-crossing occurs at the beginning of the trace (left-hand graticle). Remove the reference from the vertical input and apply the signal to be tested without altering the time base or trigger level. The distance of zero-crossing of the test signal is from the left-hand graticle can now be measured to determine the phase.

An interesting experiment is to measure the phase shift of the audio signal at different frequencies as it travels through the stages in a CW active filter. What is the phase shift of the wanted vs unwanted frequencies?

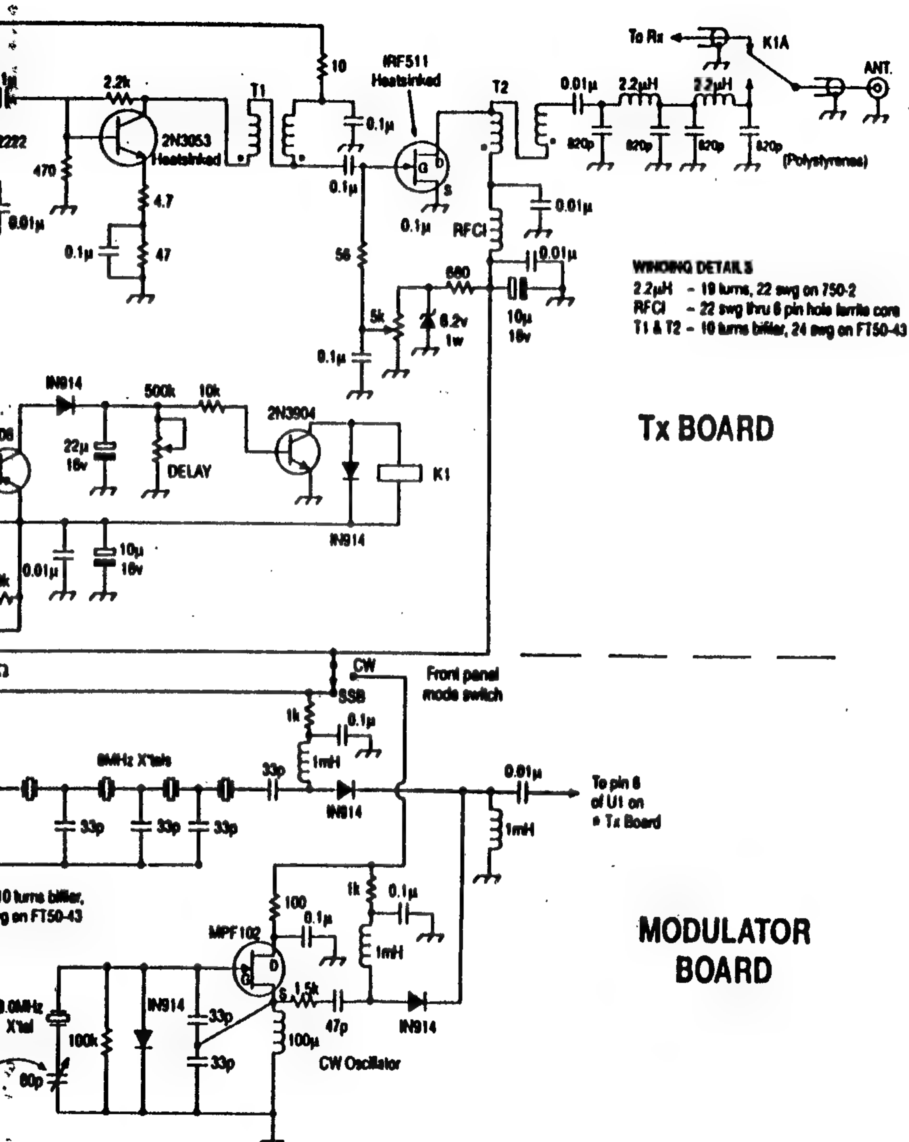
Measuring Rise and Fall Times.
In digital circuits, it is sometimes important to know the rise and fall times of a signal through a gate. In a QRP rig, this same interest could be applied to how fast the T-R switch switches. On key-down, if the transmitter turns on slightly before the receiver is turned off, it can produce a "thump." Rise and fall times are measured by triggering on the edge of interest then increase to a faster sweep to measure the time it takes the signal to reach 90% of its final level. The signal to be measured is shown on the top trace, and the expanded version on the bottom. For proper rise times, the signal being measured should be within the bandwidth of your scope.

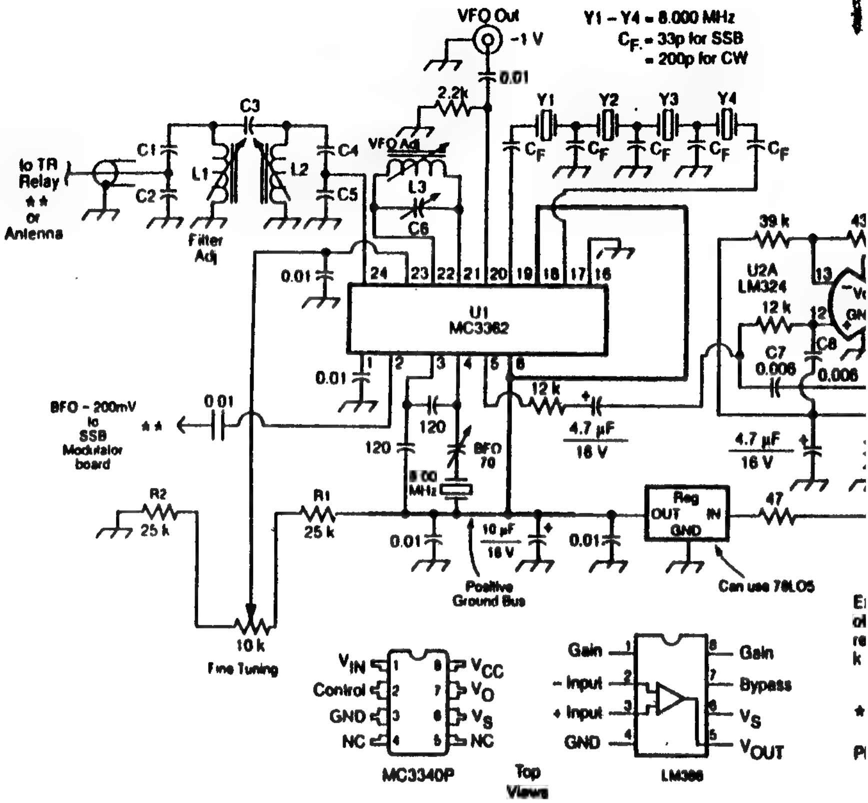


LIMITED BANDWIDTH SCOPES
Today's scopes have 500MHz bandwidths or higher. Likely your scope is much less than that. A limited bandwidth scope is still very useful to the QRPer. Say the bandwidth of your scope is 5MHz. This does not mean you can't see 7MHz signals, it just means the peak-to-peak value has lost meaning, and will likely be very weak. You can still resolve individual cycles higher than the cited bandwidth to a certain degree and make gain and phase measurements, since they are ***based on ratios.*** Most of the examples in this article explore many regions of a QRP rig without the benefit of any great bandwidth. Experiment with your scope to learn its limitations. **Use a good scope probe and make measurements with a good ground to get the most out of the bandwidth you have.**

In Part 2 - we'll probe (bad pun) into some advanced measurement techniques, even with a simple scope ... such as measuring sideband rejection, tuned circuits, filter responses, group delay, VCO phase noise, etc. (and what it all means).

72, Paul NA5N


To Rx
K1A
ANT.
IRF511
Heatsinked
T1
T2
0.01µ
2.2µH
2.2µH
820p
820p
820p
820p
(Polystyrenes)
2.2k
2N3053
Heatsinked
470
4.7
47
0.1µ
10
0.01µ
RFCI
56
680
5k
6.2v
1w
10µ
16v
WINDING DETAILS
2.2µH - 19 turns, 22 swg on T50-2
RFCI - 22 swg thru 6 pin hole ferrite core
T1 & T2 - 10 turns bifiler, 24 swg on FT50-43
Tx BOARD
IN914
500k
10k
2N3904
22µ
16v
DELAY
K1
10µ
16v
CW
SSB
Front panel
mode switch
1k
1mH
8MHz X'tals
33p
IN914
To pin 8
of U1 on
Tx Board
MODULATOR
BOARD
100
MPF102
1.5k
47p
100µ
100k
CW Oscillator
60p
X'tal



Main Tuning

L_1 & L_2 = 5.5 µH (25 turns 24 swg on Amidon L-43-2 former)

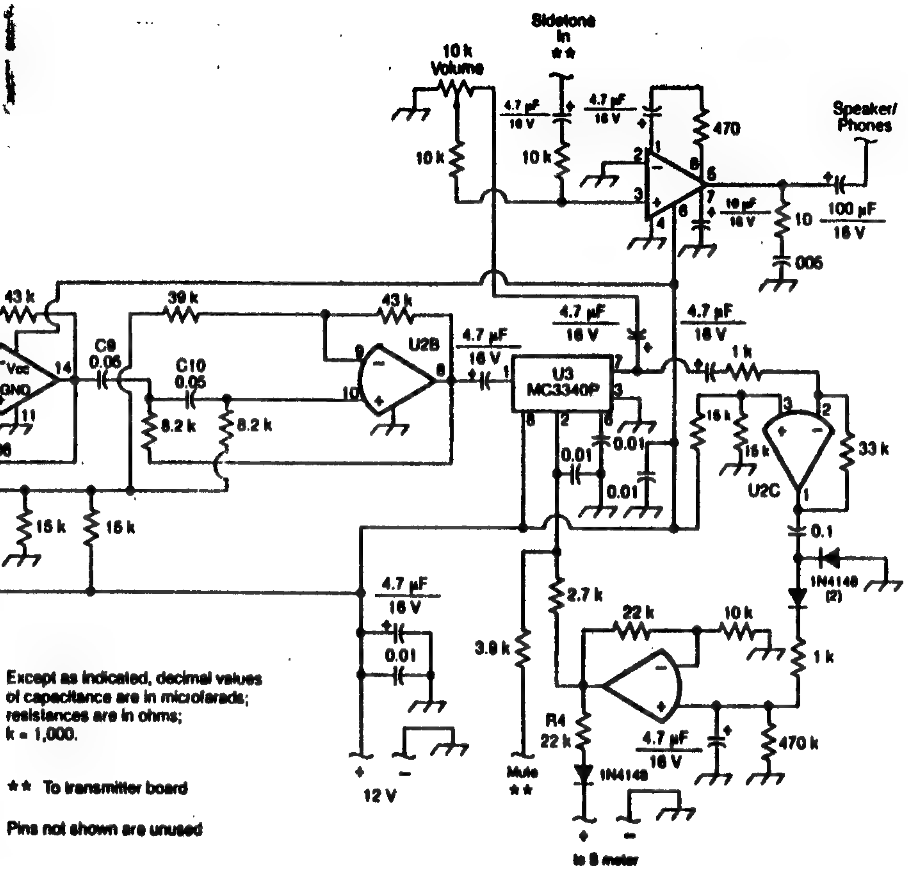
L_3 = 1.4 µH (12 turns 22 swg on Amidon L-43-2 former)

C_1 = 390 pF, C_2 = 2200 pF, C_3 = 18 pF, C_4 = 470 pF, C_5 = 1300 pF,

C_6 = 1100 pF polystyrene in parallel with 140 pF Varicap

For 80 m b
(3.5 to 3.7

80 metres SSB/CW QRP



Except as indicated, decimal values of capacitance are in microfarads; resistances are in ohms; k = 1,000.

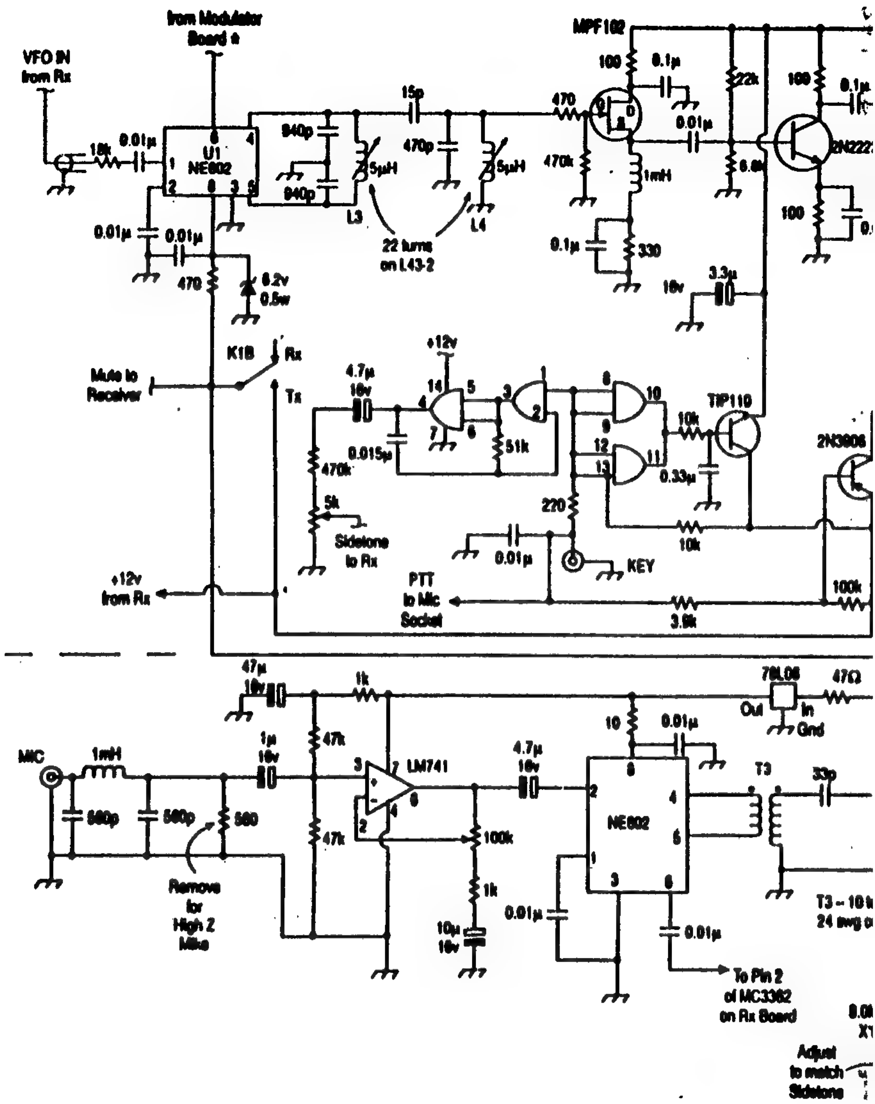
** To transmitter board

Pins not shown are unused

R_4 = 15 k to 25 k (depends on meter resistance)

band
7 MHz)

P Receiver (Schematic)


from Modulator
Board
VFO IN
from Rx
18k
0.01µ
U1
NE602
940p
15p
470p
5µH
L3
L4
22 turns
on L43-2
MPF102
100
0.1µ
470
470k
1mH
0.1µ
330
22k
6.8k
0.01µ
2N2222
3.3µ
16v
8.2v
0.5w
K1B
Rx
Tx
Mute to
Receiver
+12v
4.7µ
16v
0.015µ
470k
5k
Sidetone
to Rx
51k
220
0.01µ
KEY
TIP119
10k
0.33µ
2N3906
PTT
to Mic
Socket
3.9k
100k
+12v
from Rx
47µ
16v
1k
78L06
47Ω
Out
In
Gnd
MIC
1mH
560p
560
1µ
16v
47k
LM741
4.7µ
16v
100k
10µ
16v
NE602
10
0.01µ
T3
33p
Remove
for
High Z
Mike
To Pin 2
of MC3362
on Rx Board
Adjust
to match
Sidetone

Dayton 1997 in Pictures

Bob Gobrick, one of the organizers of FDIM speaks during the forum.

Preston Douglas (right) has just presented George Dobbs with an Altoids Tie at the FDIM event. Rex Harper donated the tie.

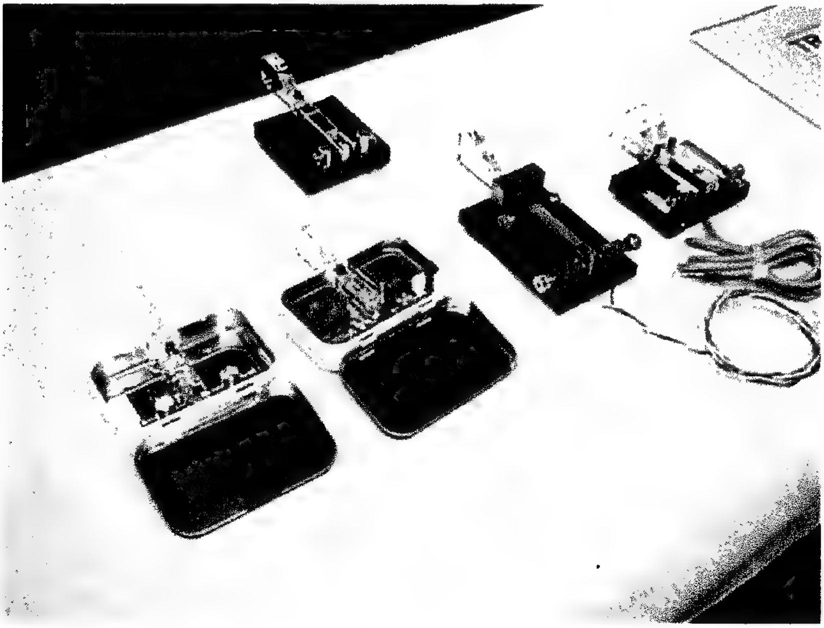
Bob Finch, Doug Hendricks, Dave Fifield, Ralph Butler, Jim Cates and Steve Cates enjoying the QRP Banquet

Doug Hendricks, KI6DS with Martin Jue, K5FLU, President of MFJ and NorCal member #222.

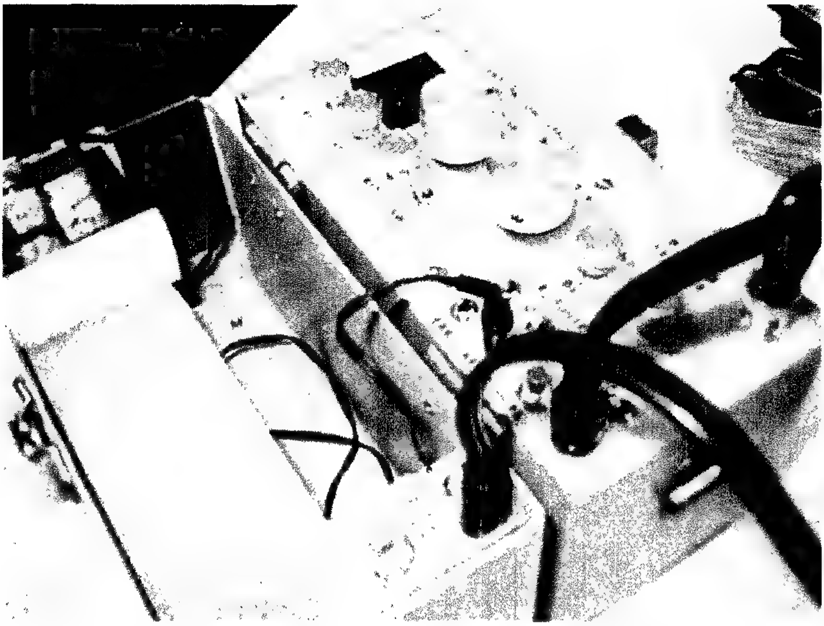
Jim Stafford, (right) announces the 3 new QRP Hall of Fame Inductees for 1997,
Dick Pascoe, Doug Hendricks & Mike Czuhajewski.

George Dobbs, G3RJV, Editor of Sprat lectures to the FDIM attendees.

Jerry Henshaw's version of a Sierra with the LDG Automatic QRP Tuner installed inside.

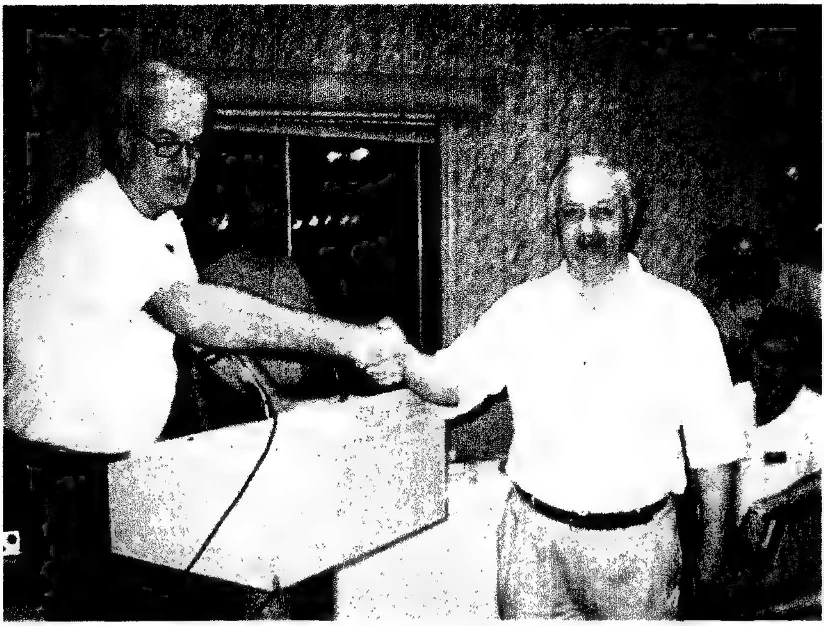


Wayne Smith, K8DD, made all of these paddles in his workshop at home. Look for a future article from Wayne in QRPp.

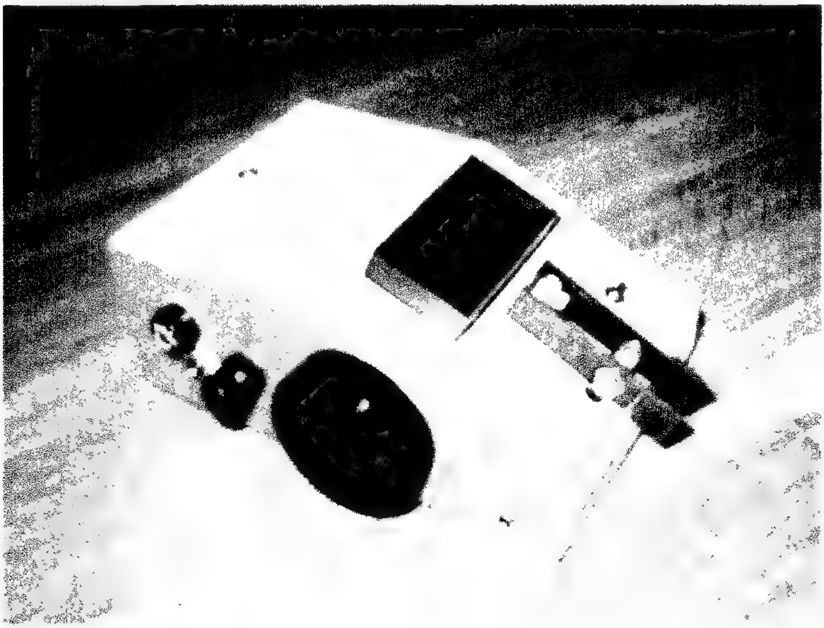


Sam Imai's winning 38 Special/Rainbow Tuner entry in the NorCal Building Contest

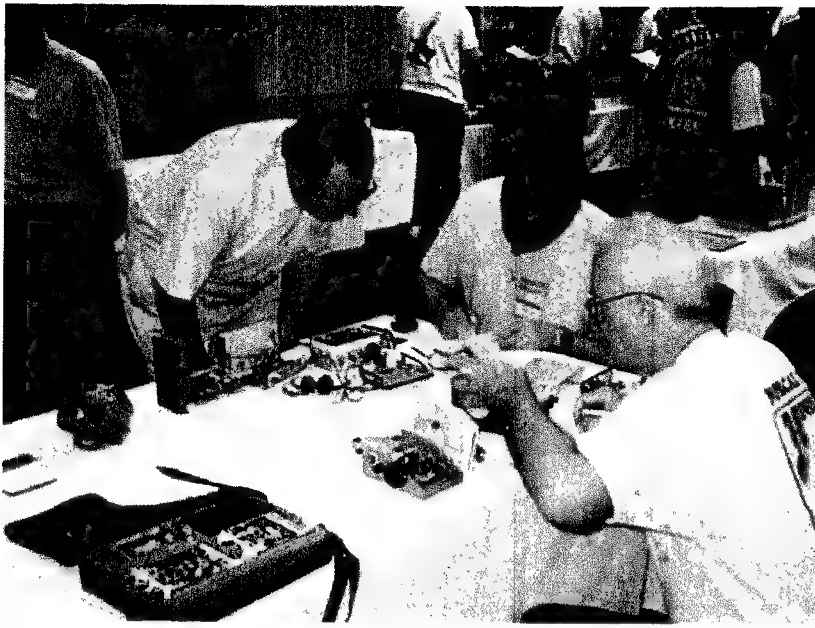
Jim Cates, WA6GER, greets another NorCal member at the Hospitality suite sponsored by QRP ARCI on Thursday, Friday and Saturday nights every year at Dayton. If you are a QRPer, this is where the action is.



Chuck Adams congratulates Graham Firth, G3MFJ who won the Rainbow Tuner building contest, passed his Extra exam and celebrated his 55th birthday, all on the same day!!

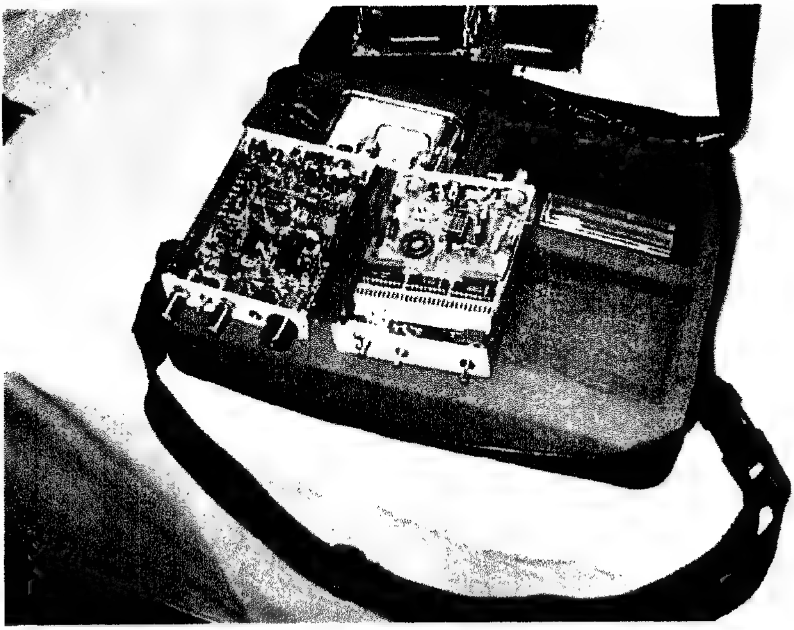


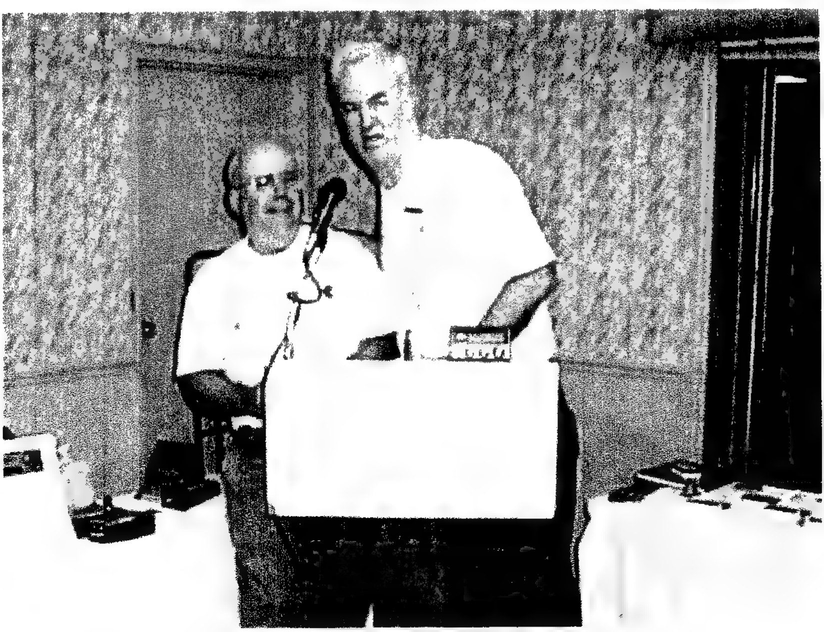
Grover Cleveland's ergonomically friendly 38 Special Transceiver



Dick Pascoe, Gary Diana and Chuck Adams deep in concentration during the judging of the NorCal Building Contest.

Bill Jones, KD7S built this beautiful 38 Special with digital readout dial.


Dennis Utley's 38 Special/Rainbow Tuner winning entry in the NorCal Building Contest


Chuck Adams (right) responding to the announcement by Doug Hendricks that he will pay for a trophy next year.

QRP Plug Paddles

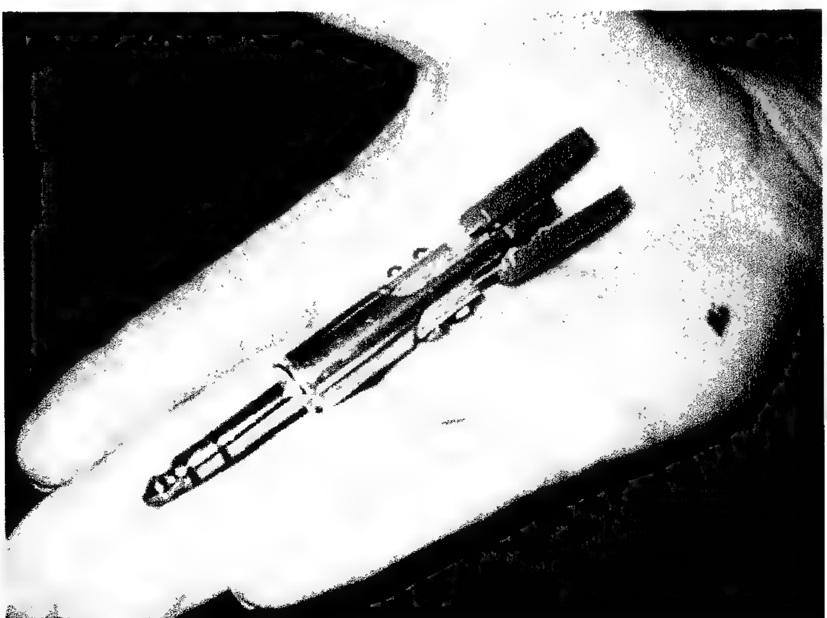
Steve Wroblewski, N6MSQ
39636 Blacow Rd.
Fremont, CA 94538

I was looking for a way to have an Iambic Paddle which would be small enough and light enough to use for QRP units such as The NORCAL units. It doesn't make much sense to have an extremely light transceiver and then have a paddle that weighs more than the rest of the unit. The battery ought to be the heaviest item in your back-pack...

I hit upon the idea of using a phone jack while I was playing with a jackfield one day in a surplus store. I found one that was falling apart because someone had drilled out the rivets holding the unit together. The springiness of the parts suggested a paddle if a center ground could be found. I then remembered the fifty or so Switchcraft jacks I had bought at that flea market several years ago. (it really pays to keep stuff eh?) After cleaning my garage until I found them, I saw that the body of the jack was perfect for the ground part and since it was an integral part of the jack body it would be sturdy enough to do the job.

To do the modification it is necessary to drill out the rivets which hold the unit together. The threads on the jack assembly most likly won't match the threads of the male plug so we will use the threads from the sleeve that is part of the jack assembly.

Unscrew the sleeve and discard the cylindrical insulator. The sleeve is then chucked up in a lathe and the center bored out to 3/8". Shorten the threaded sleeve to match the length of the threads on the male stereo plug. Take the male stereo 1/4" plug, throw away the back cover, then insert into the lathe chuck and machine



Steve Wroblewski, N6MSQ holds his QRP Plug Paddles

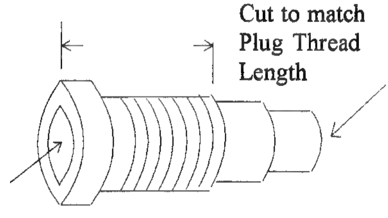
the threads down until the threaded sleeve slips over the rear of the plug. The last thing to do to the male plug is to remove the ground crimp by cutting it flush to the body. Solder the new threads onto the plug by sweating the parts together with a propane torch. This must be done quickly to avoid burning the insulating parts inside the plug. Now the male plug has threads which match the jack body.

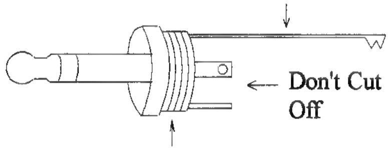
The next step is to fabricate an insulated center that will fit the hole of the jack body. I used 3/16" thick fiberglass. I first traced the shape of the hole onto the fiberglas with an Xacto knife then using a jewelers saw cut just outside of the line. This leaves the part slightly larger than the hole. I then file carefully until I have a press fit. A couple of drops of crazy glue will make a permanent connection.

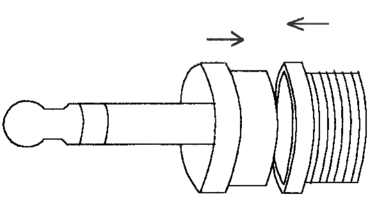
Now I take one of the parts which used to make connection to the plug and turn it end for end. I use the holes in the end to choose the right sized drill and to locate the holes to be drilled in the newly installed insulator. The solder tabs need to be trimmed slightly to fit inside the jack body. Once the holes are properly located and drilled it only remains to stack up the jack parts and instead of rivets I use 4-40 x 9/16" bolts,nuts & lockwashers.

The last step is to make the paddle handles. The paddles which are shown in the photograph are made of some brown fiberglas which I cut out with a jewelers saw. I have also made paddle handles from ebony which I salvaged from an old violin fingerboard. I like the smooth feel of ebony when the paddle is complete.

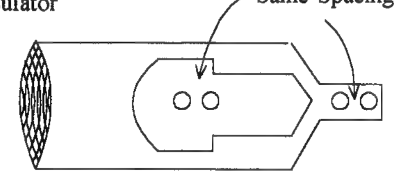
I have enough of these jacks to make up about 50 paddles. You can reach me on e-mail at n6msq@ricochet.net The price for a finished paddle is $20.00 Good luck and Happy QRPing. Steve N6MSQ

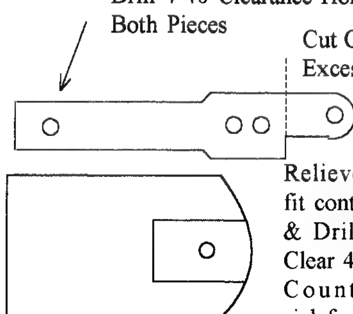






Slide Together and Sweat Solder





The DB 80, an 80 M SSB/CW QRP Transceiver

by Dr. T. C. Choy, VK3CCA
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Choy@pa.msu.edu

[Note: This article printed with permission by Amateur Radio magazine which first published this article in April 1997. The shematics referenced can be found in the center fold out section of QRPp.]

Introduction

What do you get when you cross an American Breed with an Australian Diamond? The answer is the Diamond Breed, a new QRP transceiver which I have built based on the earlier works of these authors and hence the name DB 80 (see Refs 1 & 2).

I was in the middle of constructing the Breed CW QRP transceiver when Drew's article appeared and so fate fell upon me to bring the two together. Gary's original article was an excellent account of his experience with the Motorola MC3362 chip, which was originally designed for mobile phones and other narrow band FM receivers. The resultant receiver based around this chip was excellent for its simplicity. The VFO, in particular, was a joy using only one coil and capacitor with excellent stability as compared to the need for a separate diecast-boxed FET based VFO of Drew's.

With an extra LM324 quad op amp and the MC3340 gain control chip, Gary's receiver provides better audio bandpass filtering with an audio derived AGC system which improves the receiver's overall performance as well as providing the bonus of an S meter readout. However, Gary's transmitter was not easily adaptable for SSB work. I found the use of the LM6321, 2N3866 and MRF475 combination overly expensive. Having read Drew's article I decided to redesign this part, replacing the expensive LM6321 with an MPF102 FET + 2N2222 combination solderd dead-bug style around the pins on the original PC board. I replaced the 2N3866 with a 2N3053 and the MRF475 with the IRF511 MOSFET. These combinations brought my project within the XYL's permitted recreational budget.

To bring the system to 80 m. I had to redesign the receiver front-end filter and the post-mixer filter on the transmitter. I wrote a Pascal program to do this several years ago when I needed to prove to myself that I can still cut it, i.e. to program and debug.

For SSB I used the original VK3XU modulator circuit with the exception that the BFO now comes from pin2, a buffered BFO output from the MC3362 chip unused in Gary's circuit. A little more switching, plus a separate crystal oscillator, brought the development of this system to its completion. The latter was an extravagance as I found off ballancing the NE602 which Drew used in his circuit a little inconvenient. I like to match the sidetone oscillator in the transmitter circuit with my transmitted signal.

I am sure readers will have no difficulty building this transceiver. In fact, nice circuit board lay-outs already exist in the ARRL Handbook, although I constructed my modulator board using a piece of veroboard.

Receiver Board

Figure 1 is the circuit diagram of the redesigned 80 M receiver. The main changes are the front end filter, crystal and audio filter inductor and capacitor values. The main tuning capacitor is an air spaced 140 pF variable capacitor in parallel with a 1100 pF polystyrene. I used the MC3362 varactor diode as fine tuning. Readers might like to wire in a more sophisticated RIT system with relay or diode switching. I found my circuit simple enough to use and leave it to

the big boys with their expensive sets to RIT tune into me if I am slightly off frequency.

Two extra pin connections were made to the board, one to pin 2 (the BFO output on the MC3362 chip for the transmitter) and another to pin 7 of the LM386 chip to provide extra muting (see later). Construction of this board is straightforward but readers should know of two caveats that caused me some aggravation. The capacitor on pin 1 of U1 should be checked for quality before soldering. My first prototype drew 100 ma of current and overheated the chip on completion due to this faulty capacitor. You can see my frustration in diagnosing this fault.

The ARRL's circuit board in the 1992 edition contained certain errors that required correction. Pin 11 on the LM324 was left ungrounded. Pins 6 & & of the MC3340 and LM386 chips were incorrectly wired. These errors led to a 10 dB loss in gain in my prototype board. The 78L06 chip is now rather hard to get but I found no loss in performance replacing this with a 78L05.

The most expensive part is the slow motion tuning mechanism for the main tuning capacitor. I could find no cheaper alternative and had to pay $23 at DSE. A plastic couple is essential as hand capacity makes tuning impossible. I solved this when I found an old plastic rotary switch which, when dismantled, contained all the parts needed for a coupler. No doubt readers will have other solutions for this mechanical system.

The VFO and front-end filter coil formers were purchased from Stewart Electronics. They are, unfortunately, rather expensive with the set of five coils, including two more for the transmitter board, costing almost $20. I am sure readers who have old transistor radio coil formers or the DSE R5040 coil set would like to experiment with these alternatives.

The receiver is very sensitive on this band, especially if your comrades on air are mostly not QRP. I had an S9+20 report from a VK2 station one night with a 20 dB attnuator wired in! The -123 dBm MDS quoted by Gary must be very conservative even on 20 M.

Transmitter Board

I redesigned Gary's transmitter circuit (see Figure 2), removing the crystal oscillator parts to U1 and took a pin out via a capacitor from pin 6. The SSB modulator or CW oscillator signals now come to U1 via this pin.

The LM6321, as mentioned, was replaced by a FET buffered with a 2N2222 IF amp. The driver is now the 2N3053 driving the IRF511 MOSFET power amp. This was biased as a Class AB amplifier for linear operation. This combination saved me dollars and dollars. The 2N3053 cost $1.25 from DSE, and the IRF511 is about $3.50 from Tandy. I later bought a whole bunch from SIM LIM's in Singapore for $1 each! The original MRF475, 2N3866 plus LM6321 combination would have exceeded the budget for the whole project three times over! In particular, the latter video chip could only be purchased from Farnells at $7 each if ordered in bulk. the keying power transistor TIP110 can be any NPN type capable of switching about 1A.

I have detected no bugs while constructing the transmitter board, whcih worked like a charm the first time. I do recommend keeping the oscillator components to U1 in initially and then removing them when the TX board has been debugged and checked. The only minor problem on SSB was with RF feedback. This was more a function of the simple case I used. With a poorly matched antenna the muting circuit on the MC3340 is insufficient to mute the modulated voice coming back from the audio amp. Unless you love to hear yourself speaking, my recommendation is to work into a properly matched antenna with low

SWR or to mute the LM386 completely by connecting pin 7 to the mute line. This problem is not so annoying on CW as the sidetone oscillator already makes a lot of noise.

Modulator Board

This is directly borrowed from Drew's circuit (see Fig. 2). The 741 op amp mic gain amplifier is sstandard. Note that I removed the 560 ohm resistor, although you may have to leave in if you have a low impedance microphone. The only way to adjust the 100 K mic gain resistor is on air. I recommend using a ten turn trimmer pot. I backed off the gain during early on-air tests when there were reports of over-modulation. More precise adjustments can be made if you have a two-tone oscillator and scope.

The NE602 circuit in the first mixer is a lot simpler than Drew's when I removed all the de-balancing and switching circuitry. The BFO from the receiver board goes directly to pin 6. I use a separate FET oscillator with a pair of diode switches for SSB and CW. A Cohn filter set is used in the modulator board which is a duplicate of the one on the receiver.

Construction Hints

Both the receiver and transmitter boards are wired on the original PC boards from the 1992 ARRL Handbook. Everyone has his favorite technique of homebrewing PC boards. The one I opt for is John Grebenkemper KI6WX's technique (Ref. 3) of producing a negative on transparency and then ironing it on and SLOWLY peeling the pattern off. Fortunately, my XYL is too busy pursuing other interests to know what I am up to with her iron.

The order of construction should be teh receiver board, the transmitter and then the modulator board. I developed the latter on a veroboard. The metal case of about 20 x 20 cm was also home-made from a piece of aluminum. I left enough space for a 30 W linear later on as I intend taking this rig on my travels. Unfortunately, I did not leave enought room on the front panel for a digital frequency readout, so those with such an intention should leave some more space for it. One of the unfortunate facts of life is the different ways microphones are wired. You will need to determine that for yourself and keep to the same microphone for this rig. I have four rigs and no two microphones are interchangeable (manufacturers please note)!

This rig is an ideal club project and a good introduction for someone wanting to master SSB principles.

Acknowledgments

I wish to thank VK1TX for on-air assistance (he was my first interstate QSO when this rig was fired up) as well as VK2IET, VK3OK, VK5KKT, VK7AAQ and, in particular, VK6KVU and VK6MJF for their patience and their signal reports. Although I work at the Department of Physics at Monash University, I wish to state that no resources of the university, neither parts, manpower nor workshop facilities were ever involved in this project. Allparts were purchased at my own cost and construction done on my own time during weekends in my home garage workshop. It is, therefore a "fair dinkum" homebrew which I strongly encourage any VK amateur to improve or reproduce.

The circuit in Fig. 1 is a modified version of the ARRL circuit in Ref. 1. The circuit of Fig. 2 is based on the ARRL circuit of Ref. 1 and the Drew Diamond circuit of Ref. 2.

Parts List (Main Items)

Semiconductors: MC3362, LM324, MC3340, LM386, 2 x 78L06, 2 x NE602AN, CD4001, 2 x MPF102, 2N2222A, 2N3053, IRF511, TIP110, 2N3904, 2N3906, 741, 2 x 6.2V Zeners and some 1N914 diodes.

Crystals: 10 x 8 MHz computer crystals

Inductors: 5 x L-43-2 Amidon coil formes

plus can and slugs, 2 x T x 50-2 toroids, 3 x FT50-43 toroids, a six hole ferrite core, assorted RF chokes and 1 DPDT PC board mounting relay.

Miscellaneous: 200 microamp S meter, heatsinks, slow motion drive mechanism, switches, pots, copper wire, etc.

Sources: Jaycar, Dick Smith, Stewart Electronics and Rod Irving. Some parts are also available from the CW Operators, Club through mail order.

References:

(1) A Portable QRP CW Transceiver by Gary Breed K9AY in QST, Dec. 1990 and Jan. 1991, also reprinted in the ARRL Handbood, 1992 edition and later editions.

(2) TCF Sideband/CW Transceiver for 80 meteres by Drew Diamond VK3XU in Amateur Radio Oct. 1993.

(3) Ironing out your own printed-circuit boards by John Grebenkemper KI6WX, QST, July 1993.

(4) The circuit boards referenced are available from FAR Circuits,18N640 Field Court, Dundee, Illinois 60118 Phone (847) 836-9148 Voice/Fax.

Order the following:

ARRL HANDBOOK CHP 30 FIG 33&37 A PORTABLE QRP CW XCEIVER (QST 12/90 & 1/91) FIG 33 $7.00, FIG 37 $6.00 + $1.50 shipping and handling.

TiCK-Talk: A Review of the TiCK-2 Keyer Chip

by Bill Jones - KD7S

83 Redwood Ave.

Sanger, CA 93657

My first NorCal 38 Special transceiver sprang to life in early February 1997. Besides the IRF510 5-watt mod, it also included the TiCK-1 keyer chip. The addition of a built-in keyer was such a convenience that I bought a couple more TiCK-1 chips from Embedded Research to use in my Heathkit HW-8 and NE40-40.

As luck would have it, I ran into Gary Diana (co-founder of Embedded Research) at the April NorCal club meeting and we began talking about the upcoming TiCK-2 keyer scheduled to be released in time for the Dayton Hamvention. During the conversation Gary offered me the opportunity to test and evaluate a TiCK-2 prototype. I jumped at the chance.

The TiCK-2 is a direct, pin-for-pin replacement for the TiCK-1. Besides having all the features of the TiCK-1, it also includes a 20+ character message memory. The chip does not require any additional parts or wiring changes. It simply drops into the same socket as the TiCK-1. However, there are some changes in the sequence of commands used to set the keyer's parameters.

Figure 1 shows the command sequence for the TiCK-2. Note that if you press and hold the push-button, the chip cycles from keyer mode through (S) speed adjust, (M) memory play, (T) tune, (A) admin mode and then back to the keyer. However, if the push-button is released and pressed again while in admin mode, the chip will cycle through a subset of commands which include (I) input memory, (P) paddle select, (A) audio on/off, (SK) straight key, (M) iambic mode A or B and finally back to the keyer mode. The TiCK manual describes these commands in greater detail.

The message memory feature in the TiCK-2 enables the user to store and play back a single message containing twenty or more characters.

Programming the memory is quite simple and becomes second nature after a few practice runs. Press the command push-button and listen for it to cycle through the sequence until it gets to "A", the administrative mode. Momentarily

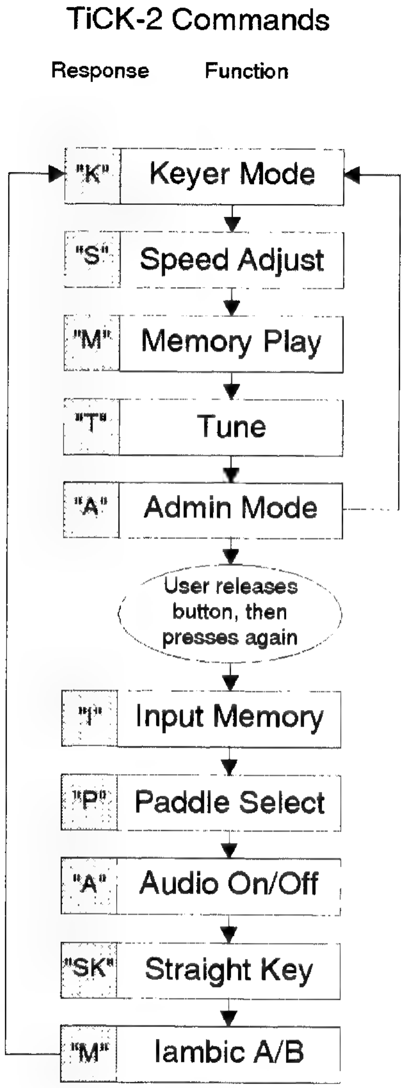

Fig. 1

release the push-button and then press it again until the letter "I" (input) is sent. Releasing the push-button at this point sets the chip up to accept input from the paddles. I was able to key in "CQ CQ CQ DE KD7S KD7S QRP K" without running out of storage space.

Once a message is keyed into memory, a single press of the command push-button stops recording and immediately plays back the message. During playback only the sidetone is activated. The transmitter is not keyed. When the playback is complete the chip resets itself to the keyer mode. If a programming error was made the cycle must be repeated.

I found it interesting that while keying a message into memory the sidetone appeared to drop a few Hertz. I asked Gary about this and he confirmed that this was indeed the case. While probably not intentional, I see this as a very nice "feature." When I hear the sidetone drop I know I need to pay close attention to what I'm sending because the memory records exactly what I key in, mistakes included.

To send a programmed message simply press the command push-button until you hear the letter "M", memory play. The contents of the memory will begin keying the transmitter and will continue until finished. However, the message can be aborted at any point by pressing either the dit or dah paddle. This is an especially welcome feature if you inadvertently release the command push-button at the wrong time.

During the review process I discovered an undocumented feature in the memory section of the TiCK-2. It is possible to play back a previously recorded message without keying the transmitter or disturbing the memory content. Simply set up the TiCK-2 like you were going to key in a new message but do not press either paddle. Instead, momentarily press and release the command push-button one more time. Whatever was previously stored in memory will be played back without activating the transmitter. I found this very handy as I couldn't always remember what I had put into memory.

The TiCK-2 performed flawlessly throughout the entire test period. At one point I removed the station ground from my 38 Special to see if I could cause the

chip to malfunction in the presence of a strong r.f. field. It did not. To check for proper character and word spacing I fed the sidetone output from the keyer into the serial port of my computer. I loaded up a CW program and set it to the "Copy CW" mode. It read the keyer perfectly. I have had dozens of QSOs with speeds ranging from 10 to 35 WPM with no errors whatsoever except those generated by hand.

I came away from the review process feeling very good about the TiCK-2. It is a rock-solid performer in every sense of the word. If it just had a built-in spell checker it would be perfect.

For more information on the TiCK-1 or TiCK-2 keyers, check out the Embedded Research webpage at http://www.vivanet.com/~gmdsr/.

Double Your Cascade Output on 20

by Dave Meacham, W6EMD
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Redwood City, CA 94062

Here's a simple way to get more power output from the Cascade:

1) Remove R80, R81, and C100.

2) Remove the 2SC2312 (Q7), and replace it with an MRF-475 ($11.50 from RF Parts, 1-800-737-2787). The pinouts are the same for each type. Fold over the emitter lead (right-hand pin, viewing from the front) to the horizontal position, aiming it to the front of the Cascade, so that when soldered to the TOP of the board the tab mounting hole lines up with the hole in the back panel. Scrape off the solder mask and solder the pin to the ground plane. Then solder the other two pins on the bottom of the board. Mount to the rear panel.

3) Replace C67 with a 1000 uF electrolytic capacitor having a working voltage of at least 3V.

4) Replace D12 with a 6A diode (I used an IR-60S6).

5) Remove trimpot R45 and use only a 150-Ohm, 1W resistor from +8TX to the diode (replace R40 with a 1W resistor).

With the mods above, my output on 20 went from 3W to 6W, and on 75 from10W to 12W, on a whistle, with a 13.6V supply. With a 12V gel cell, I now get 5W on 20, and 10W on 75. Enjoy!

72, Dave, W6EMD

St. Louis Tuner Mod--Air Wound Inductor and 160 Meters

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I finally got around to building my St. Louis Tuner. I kept in mind all of the comments I have read about tuner efficiency. I chose to build an air wound inductor.

To provide clearance to adjacent metal surfaces in the small box, I used a 0.75 inch diameter. The coil uses 16 guage tinned bus wire wound at 10 turns per inch with a total of 37 turns. This covers 80 through 10 meters. To hold the coil loops in place I cut two strips of vector board (or perf poard) 0.1 in spacing and drilled the the holes to about 0.06 inch diameter. Each strip had two rows of holes, one to hold the coil and one to hold the coil tap wires inplace while soldering. I wrapped about 44 turns of wire

around a 0.7 inch cigar tube. The coil relaxed to about 0.75 inch. Then I screwed the coil of wire into the two strips described above. Unwrap a few turns from each end for making connection to the tuner.

I mounted the coil about 0.5 inches behind the capacitors with the hot end of the coil 0.5 inches from the right side of the box and the cold end just behind part of the meter. The hot end is soldered to the capacitor and 10 taps are wired to the switch. They are at 2, 3, 4, 5, 8, 10, 14, 17, 32 and 37 turns from the hot end. They are for 10/12, 15, 17, 20, 30, 30, 40, 40, 80 and 80 meters respectively. I used the toroid and the 24 guage enamel wire with 58 turns and a tap at 47 turns to cover 160 meters on the last two switch positions. The toroid and air coil are used in series for 160.

For added versatility I included a grounded wire with the smallest radio shack alligator clip to tap the coil as needed for difficult loads. I also brought out one more tap for 80 meters at 11 turns into the toroid. The clip lead seemed like a natural with the pop open box design of the Sierra case. The clip also made it very easy to choose the final tap points.

On 80 through 10 my losses are less than 1 dB. I have not measured the 160 meter losses yet. With the clip lead at one half turn I was able to tune 6 meters. And finally I was able to fit a 12 volt AA battery pack in all the room that was left over. 72, Bob Barry, WB2CWA

Improved AGC for the Cascade

by David D. Meacham, W6EMD
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This modification moves the AGC pick-off point from the output of Q5 to a point AHEAD of the AF Gain control. It also utilizes the unused half of U8 as an AGC amplifier. The result is excellent AGC action that is independent of the AF-Gain-control setting. In addition, it provides an ideal pick-off point for the S-meter input of a KC-2.

The only above-board change is to replace R70 with a 22k-Ohm resistor. All the remaining changes will be done on the underside of the board, "dead-bug" style, with most connections going to the pins of U8, an NE5532.

Step 1: Cut the short trace going from R70 to a long trace joining C42, C41, C35, R26, and pin 4 of U5.

Step 2: Connect a jumper wire from pin 5 to pin 3 of U8.

Step 3: Connect an insulated wire from pin 7 of U8 to R70 at the point where the trace was cut earlier.

Step 4: Connect a 1k-Ohm resistor and a 1uF monolithic capacitor in series with very-short joining leads. Then connect this combination between pin 6 and pin 1 of U8 with the resistor going to pin 6.

Step 5: Connect a 75k-Ohm (or 68k-Ohm) resistor in parallel with a 680pF monolithic capacitor using very-short leads on the resistor. Leave the capacitor leads extending as they came originally. Trim and solder those two leads to fit on pins 6 and 7 of U8.

Now U8b amplifies the output of U8a and drives the existing AGC circuit. R70 was changed to provide a slower turn-on time to minimize the initial "thump" of an SSB signal.

The pick-off point for a KC-2 S-meter is the side of R70 that goes to pin 7 of U8. Approximate AF levels at this point follow:

Cascade RF-Input Power (peak-to-peak)	AF Voltage
-10dBm	4.8V
-100dBm	85mV

Now set the AGC threshold potentiometer (R64) fully counter clockwise. Turn it slightly clockwise until you see 0.5VDC at the cathode of D5. That is the setting I use. Enjoy! 72, Dave, W6EMD

1997 Dayton Building Contest Results

by Doug Hendricks, KI6DS
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Dos Palos, CA 93620

A drum roll please........ Here are the winners of the NorCal Dayton Building Contest

38 Special Division

1st - K4PQC, Phil Specht
2nd - K7TP, Grover Cleveland
3rd - KD7S, Bill Jones

Rainbow Tuner Division

1st - G3MFJ, Graham Firth
2nd - WD6BOR, Darrel Jones
3rd - No Entry (Guys, all of you who were afraid to enter missed out!!)

Combination 38S/Rainbow Tuner
(in one package)

1st - WD6BOR, Darrel Jones
2nd - AF7Y, Dennis Utley
3rd - KF6ML, Sam Imai

There were 16 entries and all were worthy of winning. The judges, Chuck Adams, Dick Pascoe, and Gary Diana are to be commended on the excellent job that they did. It took them over an hour to finish the judging. Check out the pictures in the Dayton Photo Essay in this issue. It is easy to see the concentration and effort extended.

Next year we will again have the Design Contest and the Building Contest. We are tweaking the rules a little. The Design Contest is open to any one who can come up with a project that can be used for the NorCal Building Contest. The limit is that the parts can only cost $30 and it must be qrp related. Deadline for entrants is Oct. 1, 1997. The winning entry/entries will be kitted for distribution to QRPers by NorCal and/or other clubs. The winning entrant will receive a plaque at Dayton 98.

The building contest will be held again next year and we will have a division for the design contest project/projects plus a new one, the Unlimited Class. Builders who enter the Unlimited Class will compete for the K5FO Builders Trophy, to be provided by K5FO (Chuck, I got even for last year. The ball is in your court.) The rules for the Unlimited Class are as follows:

1. Must be built after May 17, 1997.
2. Must be QRP related.
3. Must have an accompanying typed paper explaining the features, one page only.

You just cannot believe the excitement that the Building Contest created at Dayton. The RSGB sent a representative to record the event for Radcom. She took several pictures and commented that this was the real hotbed of Ham Radio excitiement. Hope to see you next year.

Special Thanks to the following: Chuck Adams, Dick Pascoe, and Gary Diana for judging, Embedded Research, New Jersey QRP Club and NorCal for the prizes, Joe Everhart and Ori Mizrahi-Shalom for designing the kits, and to all who have built them for making it possible. 72, Doug

Area 51 QRP To The Field Report

by Doug Hendricks, KI6DS
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Every year, NorCal QRP Club sponsors the QRP To The Field Contest, which is run by Bob Farsworth, WU7F. Bob does an outstanding job and we certainly appreciate his work. Last year, Paul Harden, NA5N and I started something that has turned into an annual event. We pick a place to operate from that goes along witht the yearly theme for the event for several reasons, to have fun, publicize the event, check out our ability to operate from the field and to meet QRPERs from the area. This year we decided to go to Area 51, which doesn't officially exist, but we did manage to find it. Here is my account of our Annual QRP Expedition.

Friday evening, JoAnne and I drove to San Jose to catch a flight to Las Vegas where I was to meet Paul Harden, NA5N, Ron Stark, KU7Y, and Bob Follett, AB7ST to go to AREA 51 and set up our QRPTTF station. JoAnne has never expressed a desire to go on any of my other ham radio field days, but for some reason, she insisted on accompanying me to this one. I thought that she was interested in AREA 51, UFO's and all of that (she never misses Robert Stack's TV show). But, when we got to Vegas, she informed me that she didn't want to go to the "ham radio" thing. Boy was I surprised.

Paul met us at the airport and we gathered the gear (by the way, the gate personnel in San Jose were really curious about the W6MMA SLV coil, but didn't even look at the MFJ 259 which looks to me just like a bomb. Think about it, LCD readout, buttons, knobs, rectangular shaped package big enough to hold a nice piece of C4).

We checked into the Excalibur, and then headed for the strip to get some gambling in. We returned to our rooms about 3:30 and set the alarm for 6:30 so I could get up and meet the guys for breakfast. After breakfast we got into our cars and headed North out of Las Vegas towards AREA 51. We found the side road that we had been told about and headed down it. Finally we were ready to set up. There was not a tree in sight, but we didn't mind.

Bob was pulling his Coleman tent trailer which was to be our operating position. We set it up, and then started to set up the antennas. We used an 80-10 meter W6MMA SLV on 40 meters, 2 40-10 meter W6MMA SLV's phased on 20 meter SSB, and an R7 vertical on 20 CW. All of the antennas worked great, or at least they did after about 3:00 in the afternoon. We spent hours listening to dead bands. It was like we were in an RF Black hole. I made 4 SSB contacts, all with

Paul Harden, NA5N sets up the W6MMA SLV antenna for the QRPTTF Area 51 operation. Note the Coleman Camper in the background supplied by Bob Follett, AB7ST.

stations in the Nebraska QSO party. All of them said I had an excellent signal and were worked on the first call. Trouble was, those were the ONLY stations I heard on the band. I called CQ many, many times but no one ever came back. Finally, about 1 PM I gave up and went to work CW with the other guys. QRP SSB just does not work in small combo QRP contests in my opinion. It works fine on Field Day and in Sweepstakes when there are lots of stations on looking for contacts. But it has been my experience that it is very tough going using SSB QRP in a small contest. It is far more productive to use CW.

The bands were in terrible shape when we first got on the air, about 11:00 local time. They did not improve until about 3:00. We were sitting around talking about QRP, and Paul said that we would not set a record for QSO's, but hey, we would for dollars per QSO at this rate. At one time I had 3 qso's and figure that it cost me about $167 each. But that would improve.

Suddenly at about 3 PM, the signals came. N4ROA was the first one that we all worked. Paul worked him first, then I called him, then Ron, Wow!! a contact. Then Bob noticed something strange. The wind all of a sudden switched directions and started blowing from the opposite direction. This was a 180 degree change in wind direction, and it happened right now!! Every one of us looked at each other, gulped and searched the skys. But there was nothing to see. So, it was back to the radios, and wow, now there were all kind of signals. Strange, very, very strange.

Ron grabbed his NorCal 40, powered up his laptop with the logging software, and that was the last that we saw of him for another 2 1/2 hours. Paul got on 20 and used the Sierra that Bob

Bob Follett, Monte Stark and Paul Harden Stand beside the Area 51 Fence.

brought. Every once in a while, Paul would take a break and Bob and I would slip in for a few minutes. But the best part was being able to visit with Bob, Ron and Paul about QRP. We talked about tons of things: QRPp, QRP Quarterly, Sprat, ARCI, NorCal, qrp-l, Dayton, Pacificon, Hamcon, various rigs, designers, and the most fun was a wish list.

We broke camp about 5:30 and headed back towards Vegas where we were to meet the wives for dinner. Sunday morning we all met for breakfast. The next thing that we knew it was 10:30 and time to go. Paul, JoAnne and I decided to go by downtown Vegas before we left. Gosh has that changed. Much cleaner and nicer than the last time we were there in 1982.

One side note. Paul stayed at the Circus Circus and was awakened at 3:00 in the morning with a fire alarm. He said that it was the best entertainment of the trip, watching all of the people come out of their rooms. It was entertaining but a little scary seeing some of these ladies without their makeup on and with their hair not perfectly combed. There was a small fire in a room, but they put it out with fire extinguishers.

We returned the rental car and on the bus going back to the airport, the driver asked us where we had been, (he noticed the SLV poles). We told him Area 51 and about our expedition. He then proceeded to point out the "Joshua" fleet of 737s that take off every day and fly to Area 51 (which doesn't exist).

Lots of fun, and the purpose of QRP TTF was fun, so we were successful. Now, we have to think of a theme for next year. I have the perfect place to operate, just have to think of a theme to make it work. The place? Well, Ron Stark says that he can get us permission to operate from the Mustang Ranch near Reno, and says that he can probably get the crew to pose for a group picture with us!! Ok guys, help us out. What is a theme that we can use next year and have the Mus-

tang Ranch fit in?

I had a great time. Thanks to Ron, Paul and Bob for making the effort to meet and have a great time in Las Vegas. Bob deserves special commendations for driving down from Park City with his Coleman tent trailer. They are fantastic to operate from in the field. Thanks Bob for all of your extra efforts. 72, Doug, KI6DS

Bob Follett and Doug Hendricks with an Area 51 sign that was liberated for the photo session. The picture is taken inside Bob's Coleman Tent Camper.

Build a Simple Portable Operating Table

by Doug Hendricks, KI6DS
862 Frank Ave.
Dos Palos, CA 93620

Have you ever seen a place that just cries out that it is the perfect place to set up a QRP field station, except that there is no table to operate from? If that has happened to you then this just might be the project for you.

The table in this article is 2' x 4', and is 28" high. It is built from simple materials that are available from any hardware or lumberyard, and best of all, the only tools required are a handsaw and an electric drill.

I started my project by going to the local discount lumber yard/hardware store, Orchard Supply. There I was able to pick up all of the following supplies:

1	24"x48"x 3/4" AC Plywood
2	1 x 2 x 8' White Pine Strips
20	1 1/4" Sheetrock screws
4	1/2" Pipe Floor Flanges
16	1 1/2" x 1/4 x 20 Flathead Screws
16	1/4"x 20 nuts
16	1/4" lockwashers

4 1/2" x 27" galvinized pipe, threaded on both ends.
4 1/2" pipe caps

I then went home, parked my pickup on the driveway and used the tailgate as a sawhorse to build the table. The first step is to cut the strips of 1 x 2 to reinforce the edges of the table. This was a simple matter of placing one of the 8' pieces on the plywood, and marking it to cut 48", making sure that one end was flush with the edge of the plywood. I then cut the other 48" piece of 1 x 2. Next I placed one of the strips on the bottom side of the plywood, and using the 1 1/4" sheetrock screws, I attached it to the plywood. Use a drill bit that is the same size as the screw to drill a pilot hole through the 1 x 2 so that it won't split when you drive it in. Fasten the other 1 x 2 x 48" piece to the other side of the plywood.

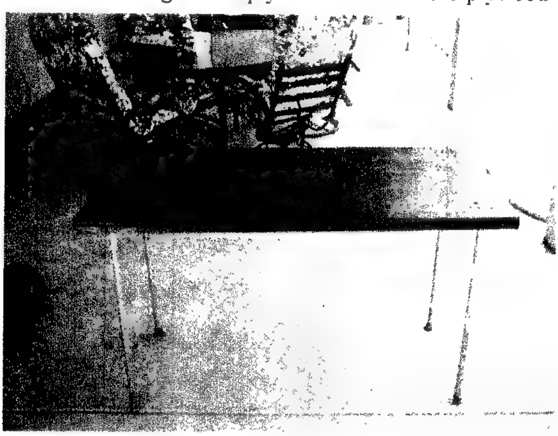


Fig. 1 KI6DS Portable Table

Now, take one of the pieces of 1 x 2 that you have left, hold it where it goes on the bottom of the table and mark and saw it to fit. Do the same with the other end. Drill pilot holes for the screws, and mount both pieces to complete the frame as shown in Fig. 2.

The mounting of the floor flanges is easy to do. Put one in the corner made by the 1 x 2's and drill 4 holes that are 1/4" in diameter using the floor flange as a template. Be sure to put screws in the holes temporarily to hold the flange in place as you drill the holes so they will line up when you are finished. Repeat with the other 3 pipe flanges as shown in Fig. 2.

Now, turn the plywood over and counter sink the holes that you have drilled. Then, place the 4 screws that are 1 1/2" x 1/4-20 FH, in the holes, turn over the plywood and mount the pipe flange, followed by a lockwasher and a nut. Be sure to tighten the nuts opposite each other and get them good and snug.

Repeat with the other three pipe flanges and you are just about finished with your table. When all of the flanges have been mounted, turn the table on its top upside down and mount the four pipe "legs" as shown in Fig. 3. Don't forget to put the pipe caps on the bottom of the legs to keep the legs from sinking into the ground.

The nice thing about this table is its portability. When you want to haul the table, unscrew the four legs, place them in the trunk of your car, put the table top in and you are ready to go.

I finished my table by painting it forest green to match the scenery of my favorite spot in the Sierras. The cost of the table will vary, but my cost was about $20. I have had my table for several years and it continues to hold up well. My wife and I take it with us on every camping trip as it serves very well to hold up a camp stove and as a food preparation table for camping.

Enjoy, 72, Doug, KI6DS

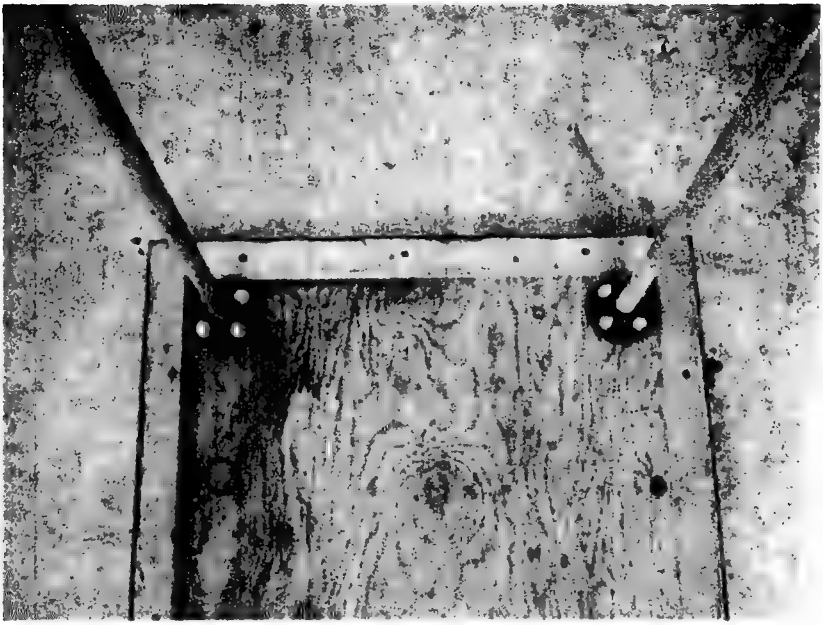


Fig. 2, KI6DS Portable Table showing mounting detail of pipe flanges and 1 x 2 reinforcement strips.

Fig. 3, KI6DS Portable Table, Bottom View

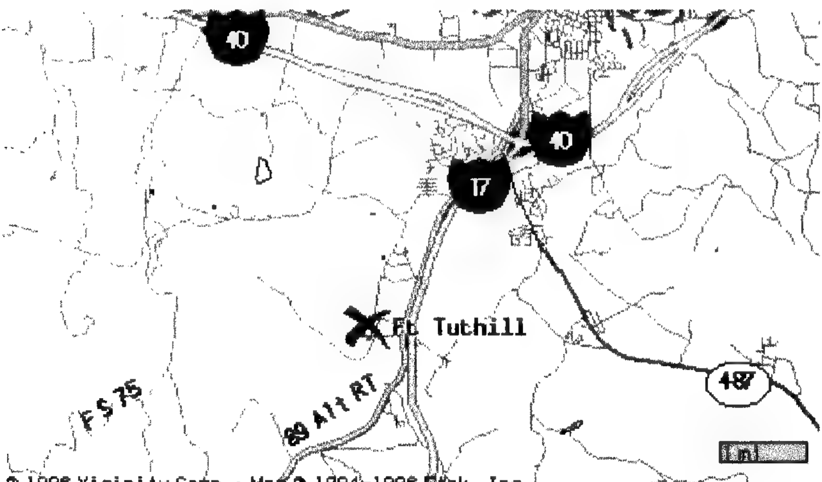
First Annual

Fort Tuthill QRP Symposium

Sponsored by Arizona QRPers

in conjunction with the annual Ft. Tuthill Hamfest
Flagstaff, Arizona
July 25, 26 & 27

For more information contact Roger Hightower, 1265 W. Kiowa Circle, Mesa, AZ 85202 or Bob Hightower's QRP Web page at http://www.dancris.com/~ki7mn/tuthill.htm



If you are coming from Phoenix, go North on I-17 to the Pulliam Airport exit just South of Flagstaff, and head West. At the junction with US 89A (just across the freeway), turn North (right) and go to the entrance to Fort Tuthill.

If you are coming from the East or West via I-40, exit onto I-17 South at Flagstaff, go South to the airport exit, take US 89A North to the Fort Tuthill Sign.

The hamfest talk-in is 146.98- with a 100 Hz PL tone. The QRP talk-in/hamfest frequency will be 146.460 Simplex, to keep the s/n down.

Plans include a QRP symposium, with Doug Hendricks, Jim Cates and Cecil Moore at this time, as well as a spot with rigs/antennas, etc., from the ScQRPions and other qrp'ers to be available. Might even have some souvenirs available.

There is a group camping area available, so e-mail Roger if you need a site. He also has plans for a cook-out and show and tell on Saturday night. Should be lots of fun.

NorCal QRP Club

Announces

The Second Annual West Coast QRP Symposium

at Pacificon 97
held at the Concord Hilton Hotel
Concord, California
Saturday & Sunday, Oct. 18 & 19, 1997

NorCal will again sponsor this highly successful QRP Event. We will have the following speakers who have tentatively agreed to speak.

Paul Harden, NA5N
Roy Lewallen, W7EL
Dave Benson, NN1G
Gary Diana, N2JGU
Brad Mitchell, WB8YGG
Wayne Burdick, N6KR
Dave Gauding, NF0R

There is no additonal charge to attend this event, other than the admission to Pacificon which has been $3 in advance and $5 at the door in past years. We will have 6 QRP sessions featureing the above speakers, and then plan on attending the NorCal QRP Hospitality Suite Saturday evening, starting at 7:00 PM. This will be a time for show and tell of your favorite QRP building projects. This year we will have an open building contest. You may enter any homebrew QRP project that you have built since Pacificon 96. Prizes will be awarded the top 3 entries. NorCal's definition of homebrew is that if you built it, it is homebrew. All of the speakers will be in attendance at the Hospitality Suite and look forward to meeting each and every one of you. The Concord Hilton has special rates for Pacificon. Call early to assure a room reservation.

QRP HINTS & KINKS

A NorCal Exclusive

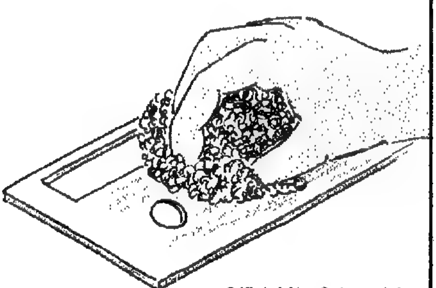
Illustrated by Paul Harden, NA5N (NA5N@Rt66.com)

#4 Painting & Labeling Rig Enclosures

Last issue we built some enclosures. This issue, we'll paint them up and apply some labeling. No matter if you are putting a QRP rig in a "store bought" enclosure, one of your own making, or a surplus item, a careful application of paint will give it that professional look.

Surface Preparation

Metal or aluminum surface to be painted should be free of burrs (from drilling) and clean of oils or finger prints. A thin coat of oil is often applied to ready-made enclosures to keep them shiny while in storage - and must be removed for proper painting.



Official NorCal model
for hand drawings: Amanda Wines

Smooth surface with steel wool or emory cloth to remove deep scratches and blemishes. If previously painted, buff-up with steel wool as well. Wash clean with warm water and soap (or alcohol) to remove polishing residue and oils.

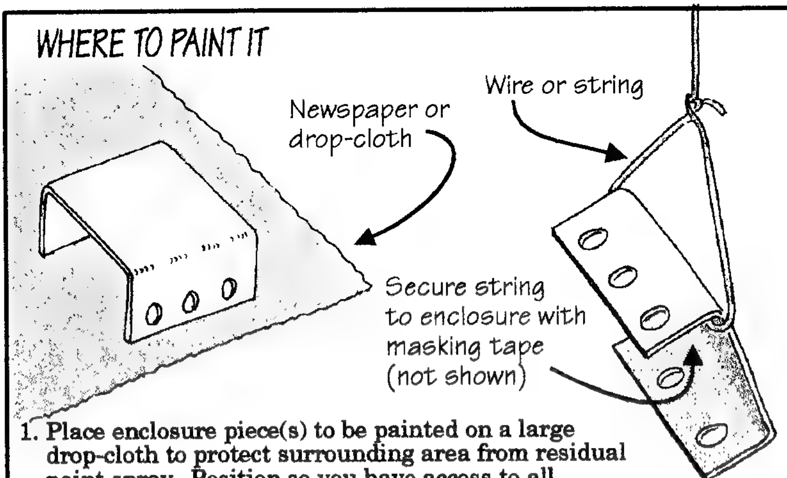
No need to polish "mirror" smooth. The minute scratches left from the steel wool or emory cloth actually help the paint adhere to the surface.

From the home office in
Flagstaff, Arizona

Bob Villa's
TOP TEN HINTS OF PAINTING

1. **Don't get in a hurry!** Take your time. Patience is the key to success.
2. Surface to be painted must be smooth of burrs and clean of oil & finger prints.
3. Two thin coats are better than one heavy coat.
4. If possible, first coat should be a primer coat for better adhesion to metal surface.
5. Let first coat dry overnight. (Primer paint dries faster)
6. Let 2nd coat dry overnight.
7. Don't handle painted items until it is thoroughly dry.
8. The operative word here is "let it dry" - like really good.
9. Paint in a well ventillated space (like on your wife's dining room table!)
10. If all else fails ... call Bob Villa.

WHERE TO PAINT IT

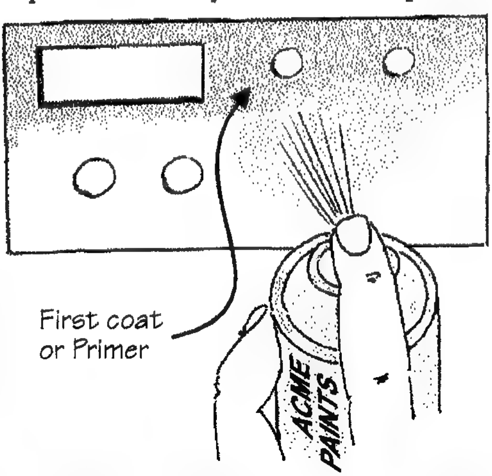


1. Place enclosure piece(s) to be painted on a large drop-cloth to protect surrounding area from residual paint spray. Position so you have access to all areas to be painted without having to move by hand. You can then reposition enclosure for painting by moving the drop-cloth or paper.
2. Hang piece to be painted by string or wire. This allows easy access to all areas to be painted. Let it hang until dry.

The PRIMER or FIRST COAT

The first coat should be a primer coat, if possible. Primer paints are made of iron or zinc oxides (and hence their bloody red color) for strong adhesion to the metal and/or aluminum surface. The finish paint (final color) will stick better to the dull primer finish than to the alumimum. Most primer paints are fast drying, allowing the finish coat to be applied within an hour or so (read directions). Clean surfaces to be painted with water and soap to remove any oil residue to prevent "bubbles" or "blisters" from forming later on. If painting over old paint, either use primer or buff dull with emory cloth or steel wool.

If you DON'T use a primer, then the first coat will be the same paint as the finish coat, or use another paint with a dull or matte finish. In this case, apply a fairly thin but even coat. Use the steel wool or emory cloth to buff out blemishes before the 2nd coat.



Let paint dry for several hours or overnight before applying second coat. Front panels and large surfaces should be laid flat to allow paint to dry without running.

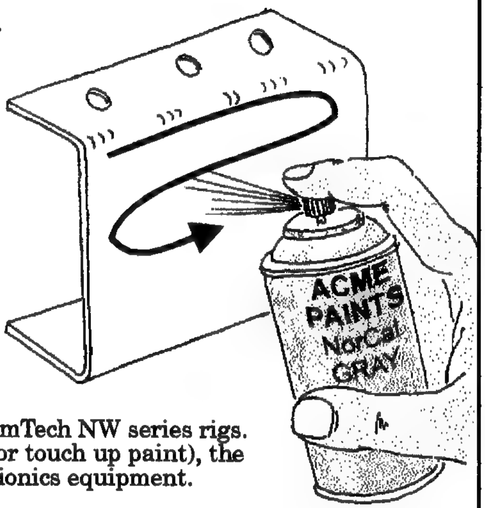
The 2nd or FINISH COAT

The second coat is the finish coat, and is applied after the first coat has dried. It should also be applied in a light, even coat, then intensifying for the desired finish and appearance. Of course care must be given to not apply too thick of a coat to prevent running and pooling of wet paint. Paint can should be held 6" or so away, painting in a back-and-forth or "S" pattern, from top to bottom, using even strokes. (From bottom to top can cause running). Stop and shake can periodically to ensure an even delivery of paint.

The PAINT COLOR

The choice of color is, of course, yours. Browse the shelves at your hardware store to find a color that hits your fancy. Some rig colors that I have seen that look nice are:

- Light to dark grey, as the Wilderness Radio NC40A.
- Avocado Green, like some commercial test equipment.
- Black (dull or gloss) like MFJ, QRP+, etc. (Requires white labeling, however).
- Porcelain white, seen on a Kanga US R2 rig - nice.
- Ivory, such as used on the EmTech NW series rigs.
- Anodized bronze (sliding door touch up paint), the dark shade used on most avionics equipment.



QUICK "PRIMER" ON SPRAY PAINTS

ENAMEL paints use synthetic and natural oils to carry the color pigments, and fit for most metals. 6-8 hour drying time.

ACRYLIC/LACQUER paints are synthetic resins carrying the pigments for most metals, in dull or gloss, with faster drying times and a hearty finish.

ALKYDS are another family of oil-based primers and finish paints for metals.

EPOXY/PORCELAIN paints dry very hard, usually a gloss finish. Use only oil-based for use on aluminum. (Some varieties are water based).

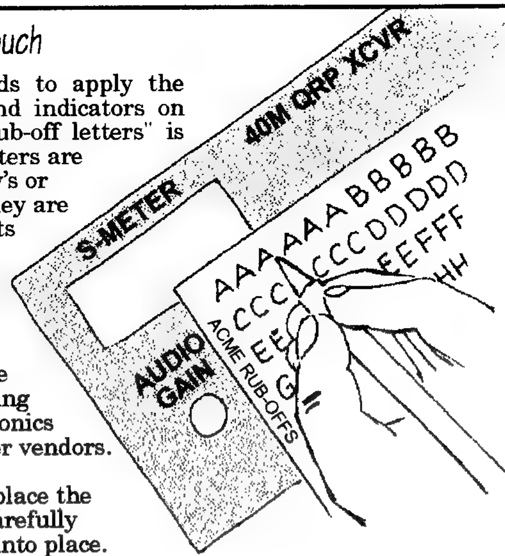
LATEX/WATER BASED paints are intended for wood, concrete, etc. and should not be used on metals.

Use only an oil based paint. Check can for compatability to painting aluminum.

Overcoat Finishes

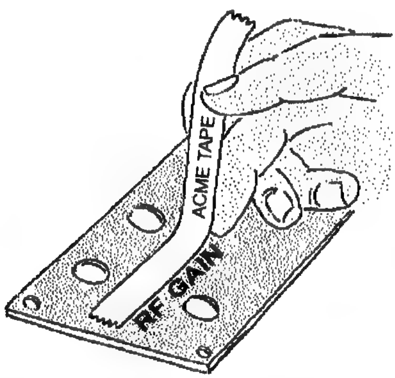
There are spray paints that are intended for over-coat finishing ... such as Clear Lacquer and Polyethylene Clear Kotes. They are a "transparent" or clear paint applied over the final color coat to give a bright, glossy shine. Such paints should NOT be applied until after you are done with your labeling. The overcoat finishes dry slowly, so allow to dry overnight before handling. Some clear lacquers contain metal flake speckeling for a unique finish.

LABELING - The Final Touch



There are various methods to apply the legends to the controls and indicators on your QRP rig ... using "rub-off letters" is discussed here. Rub-off letters are available from office supply's or drafting and art stores. They are usually sold in 8½x11 sheets in black (or white) letters. For this usage, you'll want a block type style like Helvetica or Megaron in 8-12 point sizes. *Letraset, Chart Pak and DecaDry* are brand names. *Datak* lettering sheets are specific to electronics and sold by some mail order vendors.

To apply rub-off lettering, place the sheet over the panel and carefully position the desired letter into place. The sheets are transparent to allow alignment of the letters. Once positioned, rub the letter with a ball-point pen or hard-lead pencil. Then carefully lift up the sheet to separate the letter from the sheet onto the panel. Repeat for the next desired letters.



Alignment can be tricky. If you don't have an eagle-eye to keep the letters straight, you can use a strip of masking tape. Place the tape straight, just above or below where you want the letters to go, to act as a guide line. When the line is done, it can be moved to the next desired location. *Make sure the paint is **completely** dry and hard before applying the rub-off letters or the masking tape.*

Cover completed words with a piece of paper and rub again with the scribe or a fingernail to ensure they are well fixed. Spray with a clear lacquer (see previous page) or a protective spray such as "Krylon Fixatif." Spray on a couple of light coats - a heavy coat can dissolve the lettering! Experiment with a scrap piece of metal for practice.

Rub-off letters are quickly disappearing from office and art supply stores due to the proliferation of computer lettering. It is advisable to purchase a couple of sheets now while still available. A couple of sheets will last for years.

NEXT ISSUE: Some workshop aids, such as a third-hand, soldering iron holders, etc. Ideas welcome and properly credited. Send your Hints & Kinks to Paul Harden NA5N, PO Box 757, Socorro, NM 87801. TNX

38 Special Transceiver Kits

NorCal is kitting the 38 Special Transceiver that was designed by Ori Mizrahi-Shalom, AC6AN and was featured in the Winter issue of QRPp, 1996. The 38 Speicail is a board and parts kit, with all parts that fit on the board for the basic kit, plus a doubleside, silkscreened, soldermasked, plated through commercial quality pc board. The builder will supply connectors, controls, and case, plus parts for the mods.

Ori has provide extra space on the board so that the kit can easily be modified to put out 5 W with a transistor that is available from Radio Shack! And, you can add a keyer chip that is availble for $5 and have an automatic keyer in your rig. Plus, there are many mods that have been done by the early builders and are featured in the Spring issue of QRPp.

The best thing about this kit is the cost! Only $25 for the kit and 20 page comprehensive manul. Shipping and handling is $3 per kit for US addresses, $5 for DX addresses. To order, send your check or money order, US Funds only, made out to Jim Cates to:

Jim Cates
3241 Eastwood Rd.
Sacramento, CA 95821

Orders will be shipped in the order that they are received.

Back Issues of QRPp

Back issues of QRPp are available in bound volumes only. They are bound in 1 year sets with a plastic finger binding and have a heavy card stock cover. Sets will not be broken up, and are available in 1 year sets only. The following are available:

QRPp Back Issues Pricing:

1993	-	$10
1994	-	$15
1995	-	$15
1996	-	$15

Shipping: US $3 for 1 - 3 issues.
$5 for 4 issues.

Shipping: Canada $3 for 1 issue
$5 for 2 - 3 issues
$7 for 4 issues.

Shipping: DX Europe & South America $5 for 1 issue
$7 for 2 - 3 issues
$10 for 4 issues

Shipping: DX Pacific Rim, Australia & New Zealand
$5 for 1 issue
$10 for 2 issues
$15 for 3 issues
$20 for 4 issues

All funds US funds only. Make check or money order to Doug Hendricks, NOT NorCal. Send to: Doug Hendricks, 862 Frank Ave., Dos Palos, CA 93620

QRPp Subscriptions

QRPp is printed 4 times per year with Spring, Summer, Fall and Winter issues. The cost of subscriptions are as follows

US and Canadian addresses, $15 per year, issues sent via first class mail. All DX subscriptions $20 per year, issues sent via air mail. To subscribe send your check or money order made out to Jim Cates NOT NorCal to: Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821. Subscriptions will start with the first available issue and will not be taken for more than two years.

 The articles have not been tested and no guarantee of success is implied. If you build circuits from QRPp, you should use safe practices and know that you assume all risks.

QRPp, Journal of the NorCal QRP Club
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- Is your address correct to ensure proper delivery? Please notify NorCal if you have a new call or your address has changed or will change.
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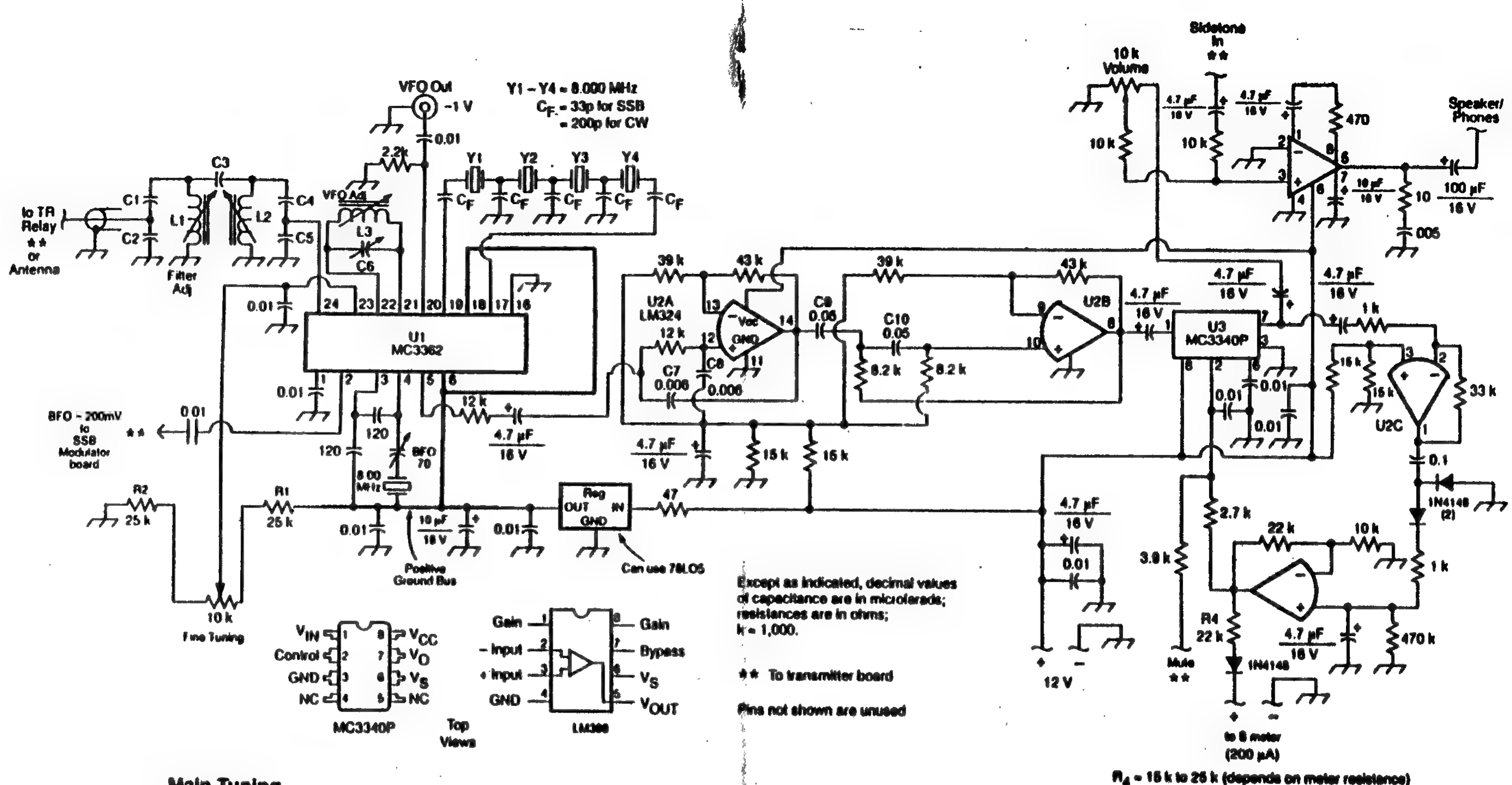
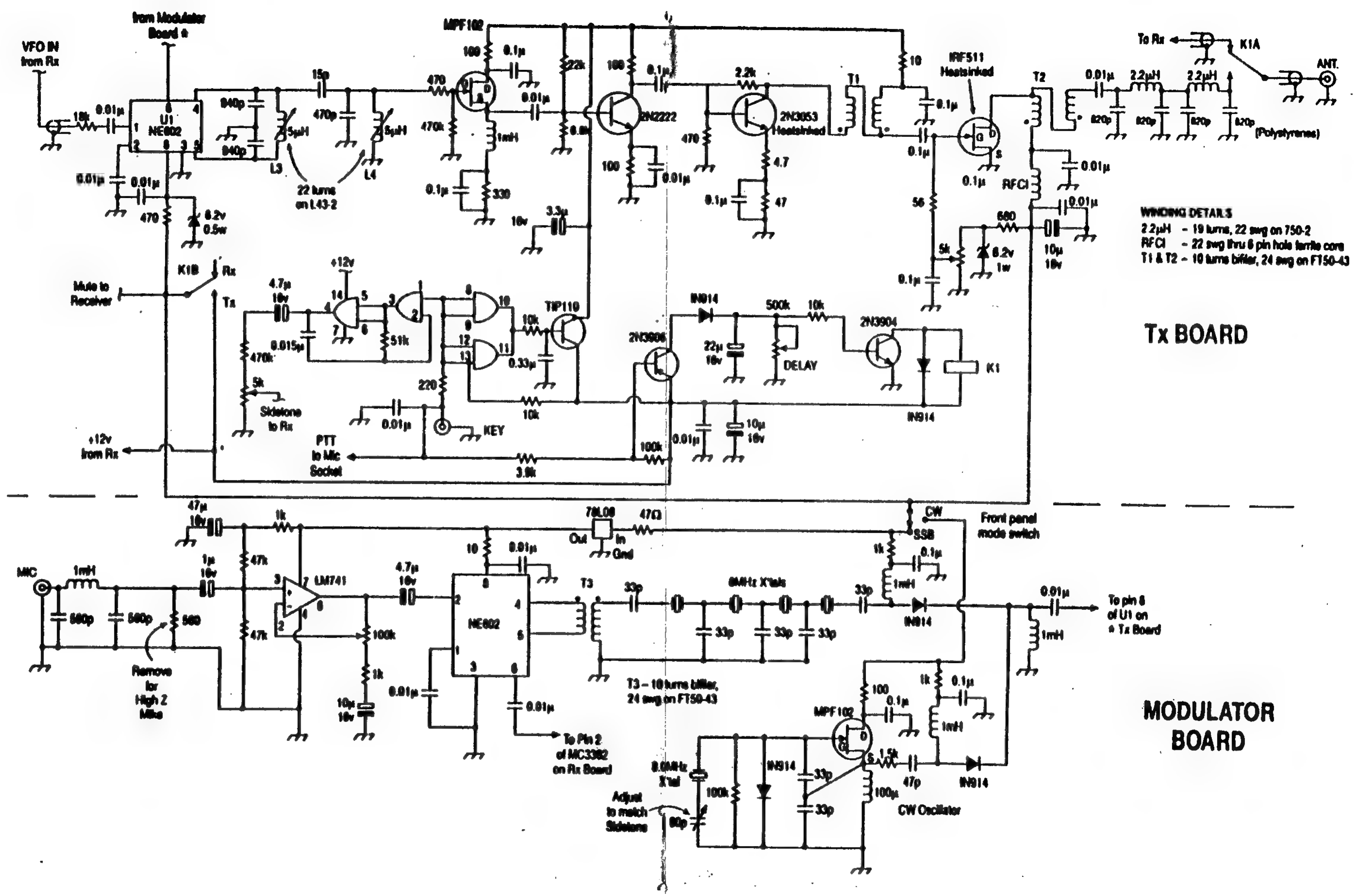


Main Tuning

L_1 & L_2 = 5.5 µH (25 turns 24 swg on Amidon L-43-2 former)
L_3 = 1.4 µH (12 turns 22 swg on Amidon L-43-2 former)
C_1 = 390 pF, C_2 = 2200 pF, C_3 = 18 pF, C_4 = 470 pF, C_5 = 1300 pF,
C_6 = 1100 pF polystyrene in parallel with 140 pF Varicap

For 80 m band (3.5 to 3.7 MHz)

80 metres SSB/CW QRP Receiver (Schematic)


VFO IN from Rx
from Modulator Board
U1 NE602
22 turns on L43-2
Mute to Receiver
+12v from Rx
PTT to Mic Socket
Sidetone to Rx
KEY
DELAY
K1
IRF511 Heatsinked
2N3053 Heatsinked
To Rx
K1A
ANT.
(Polystyrenes)
WINDING DETAILS
2.2µH - 19 turns, 22 swg on T50-2
RFCI - 22 swg thru 6 pin hole ferrite core
T1 & T2 - 10 turns bifilar, 24 swg on FT50-43
Tx BOARD
MIC
Remove for High Z Mike
LM741
NE602
To Pin 2 of MC3362 on Rx Board
T3 - 10 turns bifilar, 24 swg on FT50-43
8MHz X'tals
Front panel mode switch
To pin 6 of U1 on Tx Board
8.0MHz X'tal
Adjust to match Sidetone
CW Oscillator
MODULATOR BOARD

QRPp

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From the Editor

by Doug Hendricks, KI6DS
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First of all, there is some house keeping to take care of. Dave Meacham, W6EMD wrote me after the his article appeared in the Summer Issue to point out an error. He sent it to me correctly, I messed it up. Sorry about that Dave, but thanks for the correction. Page 54, Summer Issue QRPp, the phrase "(peak-to-peak)" should be with the "AF Voltage" heading, not with the "Cascade RF-Input Power" heading.

Wow! What an exciting summer JoAnne and I had. We started out by attending HamCom in Dallas in June, then went to Ft. Tuthill in Flagstaff in July and capped the summer with a 3 week trip to England to visit QRP friends and have a "holiday" as they say over there.

All three trips were memorable. The folks in Texas are wonderful hosts, and I would like to thank all of the QRPers in Texas who were so nice to us on our visit. I would especially like to thank Chuck Adams, K5FO, who very graciously paid our airline fare and hotel accomadations as I was a speaker at the QRP Forum at HamCom. Thanks Chuck and Phyllis. By the way, if you ever visit Chuck, Phyllis makes a wonderful chocolate desert that is to die for.

The first ever Ft. Tuthill QRP Symposium came about because of the work of Roger Hightower. Roger is an avid QRPer who is very active in the TriCity Amateur Radio Club. Last year I was invited to attend the Ft. Tuthill Hamfest and met Roger and many other highly enthusiastic Arizona QRPers. I was so impressed with the beauty of the Flagstaff site that I thought it would be a natural for a QRP symposium. Roger had mentioned that he would love to go to Dayton or Pacificon, but just was not able to work it in his schedule. I then suggested that the Arizona group host their own QRP get together using the Ft. Tuthill Hamfest as an anchor event.

To say that Roger took the ball and ran with it is an understatement. What a wonderful program he put together. He had Paul Harden, Cecil Moore, Jim Duffy, Chuck Adams, Jim Cates, Doug Hendricks and Gary Hembree. What a crew! All of the talks were well received and everyone enjoyed them. Roger also put together a cookout-potluck dinner Saturday evening that was also well attended. Be sure and put Ft. Tuthill on your list of must do things in QRP next summer. On behalf of the QRPers who attended, thanks Roger.

My summer ended with a 3 week trip to England, with side trips to Scotland and France. While in England, I was given the Royal treatment by all of the QRPers that I visited. Dick Pascoe, Tony Fishpool, George Dobbs, Steve Farthing, Graham Firth, Steve Smith, and Ted Williams all invited JoAnne and I into their homes and were most gracious hosts. I absolutely love England. It is a wonderful country, beautiful, filled with history, but the best thing is the people who live there. They are absolutely top notch.

There are lots of things in the works for NorCal. The 1998 Design Contest winners will be announced at Pacificon, and the 1998 Building Contest kits will be available soon after. Look for an article in the Winter issue of QRPp. One final thing, check the inside back cover for the announcement of the availability of NorCal T-Shirts from Jerry Parker, WA6OWR, who does the NorCal Web Page. 72, Doug, KI6DS

A Triangular Phased Array for 40 Meters

by Tim Ahrens, WA5VQK
14824 Bear Creek Path
Austin, TX 78737

This article is not an in-depth mathematical approach to antenna design, nor is it a fancy 'built like a battleship' type of antenna that costs megabucks to build. It is an article that will allow you to put up an economical phased array, and give you reasonably good performance. I have used several of the commercially available antenna software programs, and their use is shown in the article. You don't have to own these programs to duplicate this antenna. I have tried to make this article easy to understand for someone who has a limited knowledge of antenna-type mathematics. It is not perfect, nor do I claim to be an expert on antenna design, I'm just relaying my experiences to you on how my antenna system was built, and how it seems to work.

This bit of antenna work was based upon my desire to have some type of competitive antenna system, without having to resort to a lot of money tied up in towers, real estate, or high priced beams. But, before I go into the details of how to design the matching network, let me first start with a bit of history.

Back around 1985 or 86, I read a really interesting series of articles in HAM RADIO magazine written by Forrest Gherke. This multi-part article described just about every type of vertical phased array, from a two element array to a 4-square. As a lot of HAM RADIO articles did, it was complete with many technical topics that I didn't quite comprehend, including such things as 'imaginary' values, and things called conjugates! It was also based on antennas for 80 meters, which I wasn't interested in, so that made it more frustrating. I still don't get it all, but this article should help you get around the problems I encountered, and build an antenna that does work. It may not be as polished as Forrest's was, but I've found that it works quite well.

It's not too difficult to figure how to do the actual hardware work - radials, vertical elements, switch box, etc, but when it came to the actual phasing network, I just didn't get it. So much math, so little brain! Well, I figured, maybe I could just 'resize' the inductors and capacitors from 3.8 mHz up to 7.05! So that's how I built the matching network. After it was adjusted and installed, it worked great! Super front to back ratios (it's really kind of hard to quantify, as a triangular array really can't be switched forward and backward, but it definitely showed directivity! Just about anybody I could hear, I could work, barefoot too!

Well, after a couple of years, my interest in HF radio waned, and the array wasn't used much. Then, in May of 1992, we had a tremendous wind storm here, and all of the vertical elements blew down (as well as my 35' tower and TH7DXX antenna). My neighbor, N3BB, lost four towers that Saturday night.

More recently, I have once again gotten interested in working the low end of 40 for QRP DX, rag-chewing, and fox hunting, and decided it was time to press the array back into service. The ground system was still quite good, but all of the push-up poles were history. I took the matching network back to the shack for a cleaning, but I wasn't ready for what I found inside. The relays had corroded shut, as well as the variable capacitors. Boy, what a box of yuck! Oh well, let's rebuild it.

It was then that I realized that I couldn't remember how to tune it up, or even if I had built it correctly. I also real-

ized that I should have understood what each of the vertical elements radiation resistance is, as well as how they interact with each other. So, off I went, to find that magical piece of equipment that would tell me what each elements resistance really was, both real, and imaginary. I used my noise bridge to check each of the elements, but the readings that I got from that were nowhere near what I had expected, nor seen published in any article. I got a copy of ON4UN's book - "Low band Dxing", and started to get some education. This is an excellent book, and well worth purchasing. It goes over just about all types of antennas usable for HF!

Ok, how to build it?

First, the real work - concrete, landscape timbers, spools of wire, push-up poles, and lag bolts!

Triangular Array

This means that you put three supports, spaced in an equilateral configuration .289 wavelength apart (34.87 feet) into the ground. Remember, that with this design, the three directions are from each vertical element through the other two. Be sure to take this, plus the direction of 'true' north into account when you set the poles. It's not too hard to change the location of the poles given that you haven't put in the ground system yet! Keep this in mind, and measure things a couple of times just to be sure.

How much space do I need?

The spacing of the elements, plus 1/4 wavelength radials around each of them, comes up to a triangular area of 100' by 100'. In my system, I have a 30 foot oak tree sitting between two of the elements. In reading several accounts of antenna systems, the presence of foliage in an array doesn't make much difference.

Originally, when I built that first array, I put a lot of time and effort into the actual hardware of the vertical elements, and the radial system. I buried landscape timbers (with about 2 feet sticking out of the ground), and bolted the push-up poles directly to them with lag bolts. Even in wet weather, the swr doesn't seem to change much, so I don't guess that it is too bad of an idea. It certainly is 'cost effective'. The radial system starts with a loop of number 00 copper wire, about 1' in diameter. One was placed around each vertical element. To that loop, I strung out 80 quarter wave length long strings of wire. Before the vertical element was placed on the landscape timber, I put a nail in the top of the post, and used a tape measure to 'draw' a 1/4 wave diameter circle. Next, I took 6" long pieces of 3/8" re-bar, and hammered them into the ground.. leaving about 1 1/2" sticking up. Now, I soldered each radial to the loop, and then cut it off and tied it to each piece of rebar. Next, I went around the circle and pounded the rebar further down into the ground, so as not to have a trip hazard present.

After the radial system was complete, I sprayed the soldered 'bus' connections with clear Krylon to protect the joints. I then drilled two holes about 1 foot apart in the push-up pole, and held up the top hole against the landscape timber about 8" down from the top. With a lag bolt, I screwed it through the pole into the timber. Now, I 'walked' up the push-up pole, and when it was vertical, I screwed the second lag bolt through the pole into the timber. Note that a helper should be used to not only let you know when you are vertical, but to help it stay there! Before you go to the effort of putting up the pole, make sure that you have the correct length! I try and set the bottom joint to about half way, that way you can adjust the length relatively easily from the ground, or a couple of steps up a ladder. After the elements are vertical, and you have a coax connector installed, you must tune the element for the best 'SWR' at your desired operating frequency. Use of one of the MFJ antenna analyzers come in handy, although it is not required.

How important is my ground plane?

In the method of building the array that I am proposing, a good ground system is required! I believe that the only reason that I seem to be getting good results is because of the work that I put into the radial system. Since we will be taking 'typical' values for mutual impedance, as opposed to an actual measurement of them, a good ground system is implied. My land, which is pretty typical of the Texas Hill Country, has a pretty poor conductivity ratio. Even if you have crummy soil, you can still make a vertical system work pretty good if you put enough radials down. If you only intend to put in 'a couple' of radials, don't expect to get good or even mediocre results!

The Matching Network

After reading just about every book I could get my hands on that mentions phased arrays, it looked like there were two basic methods (valid ones) that would work. The first was the original type as described by Gherke, and the second was from W7EL, which was given a lot of press by ON4UN's book.

The methods:

Gherke's method uses three relays, some matching hardware, and three quarter wavelength pieces of coax to feed each vertical element. Read on later about 'true' electrical length. It may surprise you!

Roy (W7EL) has a different method of 'forcing' currents to the elements, and to make it switchable, you need to run two pieces of 1/4 wavelength coax to each element, and have six relays.

According to ON4UN, the Gherke method will give you a smaller window in which the gain and F/B will be maximized. In other words, it isn't as broad band as the W7EL method. I decided to use Forrest's method, basically because I had already built up a new matching box with three relays mounted, and because I didn't want to spend the extra $ on new coax! Also, I didn't feel that the lower bandwith of Forrest's method really mattered to me. I pretty much exclusively run at 7.100 and below, and the arrays' performance seems to be pretty good within these limits. Even at SSB frequencies, I still do see some directivity and F/B.

What is good performance?

Ok, I've been talking all along about 'pretty good', 'seems ok', and a bunch of other non qualified descriptions of the array. The figure below is from W7Els program EZNEC, and is a plot of a vertical array in a triangular configuration. I would say that this is a 'perfect' representation, and probably not what I have built. But, as they say, the proof is in the pudding, and my operation with QRP power levels let me get just about any DX station that I can hear. The EZNEC plot shows about 2 dB gain, but a really great F/B ratio. Sometimes gain is not really needed, but reduction of QRM is! For example, In one direction, I have heard stations that were about S8 to S9. When I switched the array, they did not even move the S-meter. On my radio (checked with a service monitor and calibrated output), this was a change of 20 dB! I think that's great!

The Electronics

Before I get into the building and calibrating of the matching network, let me take a few minutes to talk about electrical and physical lengths of coax. I have done nothing new here, (other than a bit of rewording), and all of this information comes straight from ON4UN's book. When you get ready to cut your coax to those ¬ wavelength pieces, hold on just a bit. When you do the following, you will find that your electrical and physical lengths will vary an enormous amount. It was so different, that when I finally got the correct lengths of coax, they almost didn't 'stretch' long enough to go from each vertical element to the matching box! I even had to re-position the vertical elements on the landscape timbers to make it reach!

Here's how to measure your length

EXACTLY: Take your signal source, connect it through a SWR bridge to a 'T' connector, with one of the other connections to a 50 ohm dummy load. Now, take the center of the T connector to your 'unknown' length of coax, and short the far end of the coax together (braid to center conductor). Whenever you have reached 1/4 wavelength, the SWR will be 1:1. Note that this works best if you have some method of putting out enough power over a wide range of frequencies. You will find that pieces of coax from the same 'lot' will be pretty close, but compared to other pieces of different manufacturers and dates, there will be lots of differences.

The phasing unit

The 'correct' way to build this unit would be to do the following steps:

1. Measure the impedances of each vertical element.
2. Measure the mutual conductances of the system (short out opposite vertical elements).
3. Run these numbers through ON4UN's software (it's easier than trying to calculate them by hand)!
4. Use these figures to design the box.

HOWEVER, most people don't have access to the type of test equipment that is required to really optimize the array for optimum performance. Because of this, it is easier to use published 'typical' values. The values in Table 1 were taken from Forrest's articles. These values are independent of frequency, and by using the software from ON4UN, you can get the exact values necessary to make the phasing unit. If you were to use the EZNEC software from W7EL, you could also get very close to the element impedances from Forrest's article. Note that these impedance values are the same for any frequency, with the proper 1/4 wavelength spacing, etc. With this in hand, and ON4UN's software, you could change this array to be any frequency.

Phasing unit values

The inductance and capacitance values of the matching unit are pretty easy to make.. I used the 'ugly' method of construction, and had small 1" x 1" pieces of pcb material that I hot glued to a large piece of pcb material. Each element of the box would either tie to ground, or to one of the isolated pads. The actual values of the pieces are shown on the schematic. Both L2 and L3 are wound on ferrite toroids, but since the value of L1 is relatively small, I air-wound it. During the tune-up procedures, the easiest way to adjust the inductors is with a pair of pencils. Use them to compress and expand the windings on the core. For the capacitors, I use two fixed mica caps in parallel, and an additional variable cap. This allows me to adjust it relatively easily. Depending on the amount of stray capacitance, etc you have in the system, you may have to slightly adjust the values of the capacitors. Your adjusting of the variable will show you what to do. (If the plates are fully meshed, and you are just getting close to a dip, then add an additional fixed cap of the value of the variable).

TABLE 1

Network parameters for a triangular array

Element 1
(POINT A)
Z1 = 20.4 - j10
I1 = 1@0 deg
E1 = 22.72v@-26.11 deg

Element 2
(POINT B)
Z2 = 78,4+j4
I2 = 0.5@-90 deg
E2 = 39.25v@-87.08 deg

Element 3
(POINT C)
Z3 = 78.4+j4
I3 = 0.5@-90 deg
E3 = 39.25v@-87.08 deg

90 degree coax
(POINT D)
Z1 = 98.81+j48.43
I1 = 0.45@63.89 deg
E1 = 50v@90 deg

90 degree coax
(POINT E)
Z2 = 31.81-j1.62
I2 = 0.79@2.92 deg
E2 = 25v@0 deg

90 degree coax
(POINT F)
Z3 = 31.81-j1.62
I3 = 0.79@2.92 deg
E3 = 25v@0 deg

Shunt input L
(POINT G)
Z1 = 146.08+j0
I1 = 0.37@29.22 deg
E1 = 54.59@29.22 deg

Elements 2 & 3 paralleled
Shunt input L
(POINT H)
Z2,Z3 = 76.02+j0
I2,I3 = 0.72@65.70 deg
E2,E3 = 54.59v@65.70 deg

Tee circuit
(POINT I)
Z2, Z3 = 76.02 + j0
I2, I3 = 0.72@29.22 deg
E2, E3 = 54.59@ 29.22 deg

POINT J
FEED POINT
(Coax to shack)
(paralleled resistance 146.08 & 76.02 ohms = 50.0 ohms

Before you get scared off, let's look at these figures, and points, and see what they really mean. If you were to look into the 50 ohm connector which feeds to your shack, here is what you would see: 50 ohms, if both network halves were connected. Let's separate them here, and travel down each side separately. Looking into the 'T' circuit at point I, you would see a pure resistive impedance of 76.02 ohms. The output of this circuit is also at the same impedance, as it is meant only to 'stretch' the phase angle, not do any type of impedance transformations. It's output is shifted in phase, and feeds the shunt input L circuit at point H. The output of the L circuit feeds two of the elements, and is used to convert both phase and amplitude which will feed into the 1/4 wavelength pieces of 50 ohm coax. Obviously, at the end of the coax is the vertical element itself. Backing up to point J, and proceeding into point G, the other shunt input L, it is used to match the purely resistive load into the reactive element of the coax feeder, and the 'driven' element. When you connect up both points G and I, the resistive impedance will equal 50 ohms..

Tuneup

Now that we see how the network is put together, and what the pieces are used for, let's talk about how to tune it up. All that you need here is a 40 meter receiver, a noise bridge, and two resistors: one at 76 ohms, and one at 146 ohms. You might consider using a low value carbon composition potentiometer for the resistors, unless you want to take time to mix and match 5% resistors. I used a 500 ohm carbon pot, and then used my digital meter to set it to the appropriate value.

Here we go

First, disconnect point G from the Shack's coax line. We need to measure all of the pieces separately. Next, hook up your 146 ohm resistor to point G. With your noise bridge's 'unknown' input connected to the D coaxial output (we are trying to measure all pieces of the puzzle, so we are including any stray capacitance that may be hanging around the relays. Now, set your noise bridge to 99 ohms, with a -

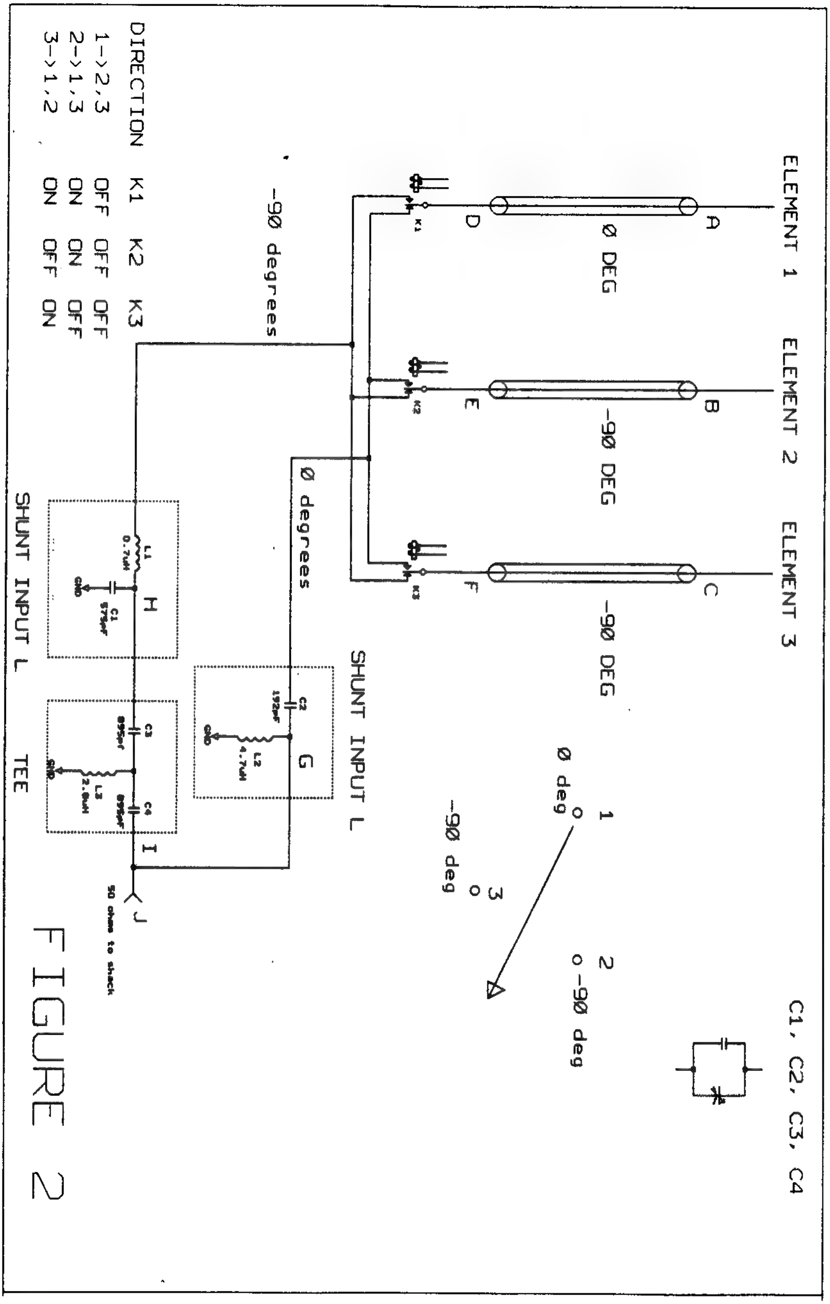
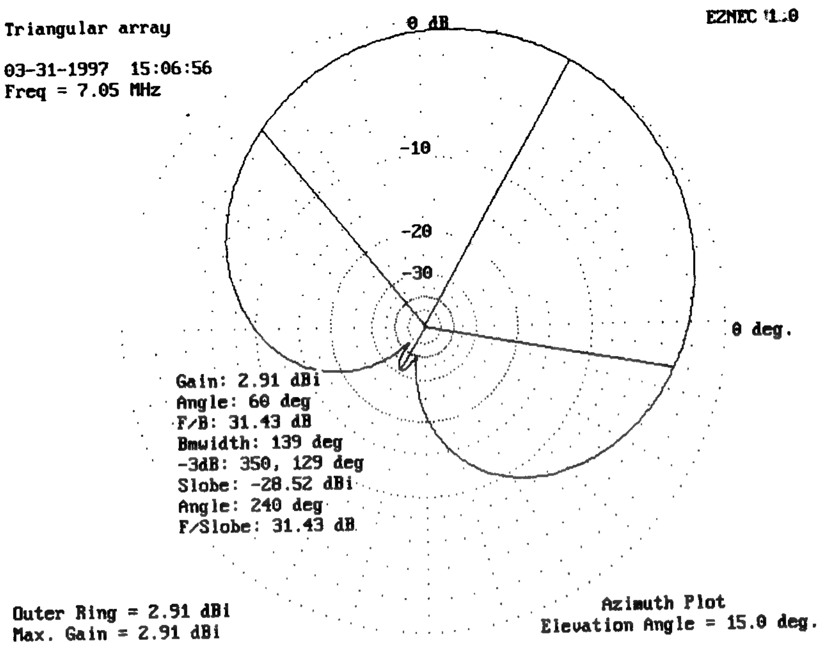
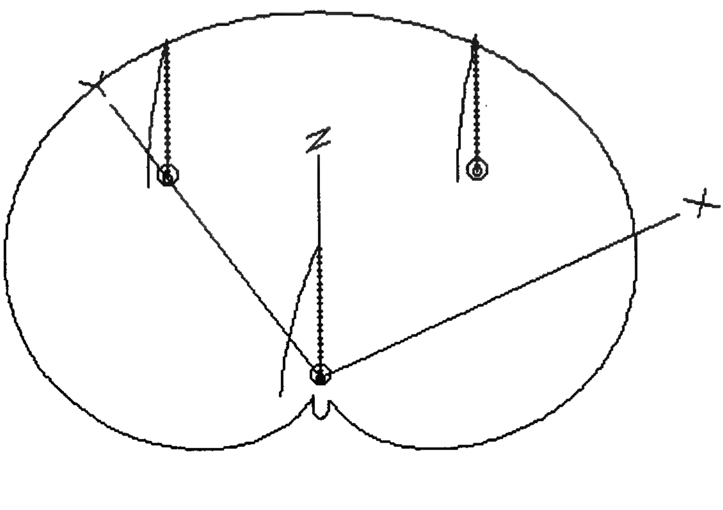


FIGURE 1 SCHEMATIC



Smith Chart of Triangular Array



Orientation of Triangular Array for Smith Chart

50 on the 'LC' scale. Adjust both the variable capacitor of C1 and L1 until you get a VERY sharp null. This completes the adjustment of the 1st piece of the puzzle. Now, disconnect point H from C3, and connect the 76 ohm resistor to point H. Connect the unknown of your noise bridge to the E coaxial output. Set your noise bridge for 15.9 ohms, and 0 on the 'LC' scale. We have chosen this 15.9 ohm value because looking at point E, we see it is actually 31.81 -j1.62. Since there are two in parallel, we must half the value. After you have gotten a sharp null by adjusting L2 and C2, move your 76 ohm resistor, and place at point I. Hook your noise bridge with a short run to the H side of C3. When I say short, I mean like less than 2 inches. Now, set the bridge for 76 ohms, 0 on the LC scale, and tweak C3, C4, and L3 for a sharp peak. When you have completed this, re-hook up point H to C3. You may then re-hook up the bridge at point E, and see if the null is still there. (don't forget to change the bridge's settings to 15.9 XXX). You may adjust things a bit here, to compensate for the error you introduced with the lines to the bridge at point C3. However, remember that there are 5 separate adjustments, and you may (probably) mess things up. In the beginning, I would NOT make any corrections, but try things out for a while. After you have re-hooked up H to C3, then connect G to I, which then presents a 50 ohm load to your shack. (parallel 76 ohms with 146 ohms). You should find that your SWR will be quite low. Only in a driving rain storm have I seen the SWR change any. Of course, I only run QRP, so there's not enough RF to ionize the water! If your SWR does change significantly, you will know that something is wrong, and can trudge out to the field, and figure it out. Look out for badgers!

CONCLUSION

There you have it, a cookbook for a triangular array. Certainly, you can improve on the design if you have the necessary test equipment, but unless you own an RF lab, it might be difficult to do. In the 1996-1997 Fox season, this is the antenna system that I used. I used between 2 and 5 watts, and the results were quite gratifying. Also, I worked many DX stations, and got good reports. Drop me an e-mail and let me know your results! (tahrens1@juno.com)

OPTIMIZED 20-METER SST

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The SST is an amazing little rig. I made a few changes to mine to widen the filter, make the tuning cover the FISTS and ARCI frequencies and be more linear, increase the offset, and increase the power output.

Filter changes:

1) C7, C8 = 220pF
2) C6, C9 = 68pF
3) RFC6, RFC7 = Mouser 43LS125 (12uH), with RFC6 mounted vertically to minimize input-to-output coupling.
4) RFC2 = Mouser 43HH474 (470uH) (stock inductor is a capacitor at 4MHz).

Bandwidth ~350Hz @ -6dB points, now.

Other changes:

1) RFC5 = 6T for 20 meters.
2) D4 = MV209 for 20 meters.
3) RFC3 = Mouser #43LS566 (5.6uH) for 20 meters.
4) Add 18k resistor from wiper of R4 to +8V side for better tuning linearity.
5) R10 = 200 Ohms for lowest spurs.
6) For 20 meters only, C10=33pF, C11=68pF, C25=100pF for higher offset (525Hz).

7) I replaced Q2 with an ECG-341 for more gain, and added a 6.8uH inductor (Mouser #43LS686) from base to emitter for better input matching. I get 3W output on a gel cell. I also changed R1 to 5k (Mouser #317-2091-5k) to spread out the effect of the gain control over more of the dial. I replaced the tuning knob with a larger one (Mouser #ME450-2036).

8) I increased the loaded Q of the resonant circuit L1, C26, and C27 by changing C26 to 2pF (lighter coupling). The second harmonic dropped by 2dB, and the spurs dropped by 10dB. The second harmonic is now 35dB down, and the spurs 45dB down in my rig.

9) Changing R2 to 2.4k moved the peak of the audio filter down to coincide with the center of the IF filter at 525kHz.Tuning range = 14.054-14.063MHz. Dial center is 14.059.72, Dave, W6EMD

REFINEMENTS TO THE 10-WATT EP-2

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This article builds on "10 Watts for Your EP-2", published in June, 1996 QRPp. With that conversion the levels of spurious output frequencies only marginally met the FCC requirements. I was not happy with the frequency-drift rate of 62Hz per hour, either, nor the poor performance of the PA transistor at 13.8V. So, I set out to correct those deficiencies.

The first thing I discovered was that the bandpass filter did not behave as well as it should have. The only suspected component was the output termination, a 100-Ohm trimpot (a blue Murata #3102). It measured 3.63uH at 4.6MHz (the high end of the VFO range). It was meant to be a RESISTIVE termination! I replaced it with a single-turn, carbon-strip trimmer (non-inductive) from Mouser (p/n ME322-6800-100). The filter behaved better. Then, since I preferred a 100kHz range of 3.75MHz to 3.85MHz for a 10-turn pot, I optimized the response to be flat over that range by changing C31 to 1500pF, and C29 to 510pF (I had previously limited the tuning range, for ease of tuning, by changing R24 to 16k).

The second surprise was that X1, a "ceramic resonator", was very rich in harmonic output. In fact, Q1 appeared to be acting as a "comb generator". This was the source of much of the spurious-signal output. An R-C, low-pass filter between Q1 and U1 was the solution to the problem. The output became a clean, 453kHz signal, with a second-harmonic 25dB down. The spurious output from the PA now easily met the FCC regulation!

The third problem was the drift. By changing C17 to a C0G type, C13 to 33pF NP0, and C16 to an NP0 type, the drift was reduced to 12Hz in one hour, after a 15-minute warmup.

The IRF-510 PA was replaced with an MRF-475 (RF Parts, $11.50, 1-800-737-2787). This transistor is a true RF device, specified for SSB service at 12W PEP. The pinout is the same as for the IRF-510, so it drops right in. What a world of difference! There is so much gain that I run R15 at 60% for 10W PEP.

A detailed summary of the refinement changes follows (this list assumes that you have already made the changes outlined in my previous article):

1) Replace R15 with a one-turn, carbon-strip trimpot (Mouser part number ME-322-6800-100).

2) Change T1 to 10T bifilar wound, with a 3T secondary overwound, on a T50-43 core. Route the center tap of the primary to 12V switched instead of 9V. This can be found at pin 13 of U1, at the input to VR1, or at K1A. Add a 0.1uF ceramic ca-

pacitor from the center-tap to ground.
3) Change R23 to 8.2 Ohms, 1/2-Watt carbon composition or metal film.
4) Remove C44.
5) Remove R3, the PA bias-adjustment pot, and replace with a 150-Ohm, 2W resistor at a convenient spot under the board, changing its source to 12V switched. The other end of the resistor goes to the anode lead of a 6-Ampere diode in the pad previously used for the wiper of the pot. (I used an IR-60s6.) The cathode lead goes in the pot pad nearest Q4. Add a 1000uF electrolytic cap, rated for at least 3V, from the anode to ground using the pads for C44.

This circuit now supplies about 0.7V of forward bias to Q4. My diode measured 0.68V, and the quiescent current was 25mA. (I found that the voltage drop across the diode drifted when using lower-current diodes. It's rock solid with the 6A diode.) I had to cut several traces and add two jumpers under the board to do this revision. You may wish to do it differently, so I've not described the details of my version. Just follow the traces and modify to the new circuit.
(See Fig. 1)
6) Change C6 to 10pF NP0 ceramic.
7) Change R24 to 16k, and add a 1N914 diode in series to ground (cathode grounded). These changes give 100kHz of tuning range, temperature compensated.
8) Add a 220pF NP0 mono cap from pin 7 to pin 8 of U1.
9) Put C39 back in (it had been a jumper).
10) Replace C5 with a 22k resistor (vertical) and a 0.1uF mono cap (vertical) in series by bending each top lead horizontally and soldering together in a lap joint. This is the low-pass filter (in conjunction with step 8).
11) Remove the 12pF caps from U2 pin 6 and U3 pin 6 to ground.

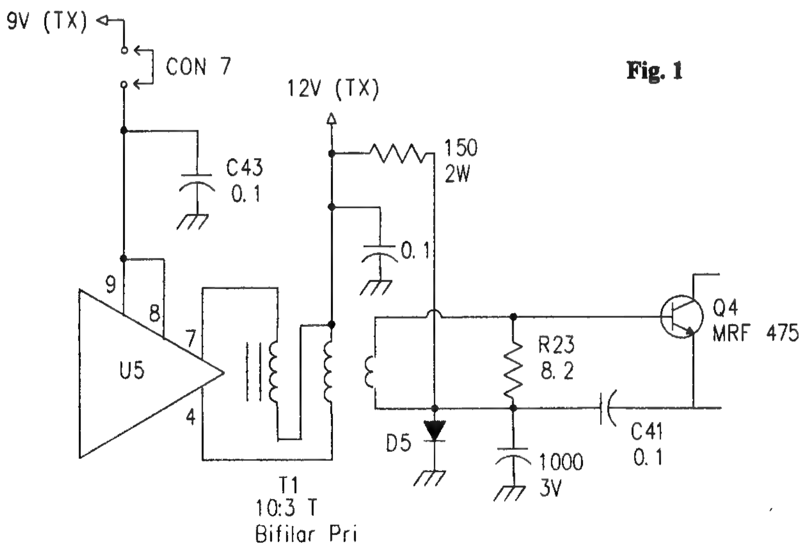
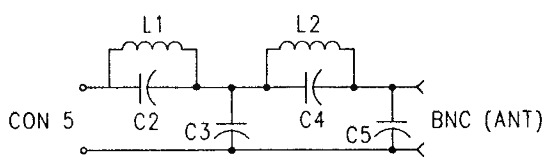


Fig. 1

Fig. 2



12) Change C12 to 470pF C0G mono ceramic in parallel with a 47pF NP0 ceramic (under the board). This improves the LFO waveform.
13) Change C11 to 150pF mica.
14) Change C16 to an 820pF NP0 mono cap.
15) Change C17 to a 470pF C0G mono cap in parallel with a 560pF C0G mono (under the board), or a single 1000pF C0G mono cap. Steps 14 and 15 reduce the drift.
16) Put C54 back in and install R27 changed to 620 Ohms.
17) Change C13 to a 33pF NP0 ceramic cap (this reduces drift by reducing the loading on the tank circuit by Q2).
18) Change R4 back to 47 Ohms.
19) Change R5 back to 2.2k.
20) At 10W output, a TO-220 heat radiator with fins is inadequate to cool Q4. I use a copper bar 0.050" thick by 7/16" wide, running from between Q4 and the board (sandwiched there) to the rear panel (insulated at the panel). I also have a hat-type heat radiator on U5.
21) To make sure that all harmonics were at least 40dB down (FCC regs for over 5W), I designed and installed a new, elliptical, low-pass filter. I recommend it. I used mica caps, but low-loss monolythic caps are satisfactory, too. (See Fig. 2)

Reset the BFO to 452.8kHz and the VFO to the desired range. Tune the bandpass filter for the most flat response over the 100kHz band (10W +/- 1/4dB is typical). Now you should have a very-clean signal with very-low drift.

72, Dave, W6EMD

Accurate QRP RF Power Measurement

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I have tried for years to develop an accurate means of measuring RF power output. While there are expensive ways to do so, my aim was for the simplest and cheapest possible way of doing so. I hope readers will agree that I have achieved this goal.

This gadget is built in two small assemblies connected together by a UHF Tee connector. One assembly is the 50 ohm dummy load issustrated in Fig. 1. It has a dissipation capability of 12 or more Watts, depending upon whether discs at the ends are made of PC board, or copper pennies. The six 300 ohm 5% metal oxide resistors wired in parallel have zero inductance and are the purest R available. I used Mouser 282-300 resistors. This dummy load is mounted on the end of a PL-259 and wired internally to it.

The other assembly, also built inside a PL-259, is the RF peak detector head. It contains only a germanium diode and an 0.01 uF disc capacitor. It detects, rectifies, and filters the peak RF voltage developed across the dummy load. Accurate RF power level is determined by multiplying the peak DC reading on the DMM by 0.707, squaring this value, dividing the result by 50 ohms, and extracting the square root, the value of which is the RF power in Watts.

W = Square Root of $(.707E_{pk})^2/50$ ohms

For the absolute purists among us, the tiny voltage drop across the germanium dode in the circuit is not compensated for. It is miniscule, and when one also considers the accuracy tolerance of the DMM and the tolerance of the dummy load, plus the fact that probably no transmitter ever built

has an exactly 50 ohm output impedance, with the possible exception that it could happen at one single frequency within its range, there is little to be gained by worrying about the diode junction voltage drop.

The particular resistors specified (Mouser 282-300) are quite tiny and look more like one Watt resistors, but this makes the dummy load quite small. Refer to the drawing and prepare the two end pieces of PC board, or if you check the piggy bank of one of your harmonics you may find real copper pennies, which are preferred. In the early 1980's the US Mint began making pennies of zinc with an extremely thin copper plating. You want two pennies with earlier dates.

Drill central holes in both discs large enough to pass insulated wire. Then drill six holes spaced 60 degrees apart just inside the edges of the discs. Drill both discs together for the neatest results. Then insert the resistor leads into the six holes in each disc and snug the discs against the bodies of the resistors. If you use pennies you will probably need a solder gun to solder the resistors to the discs, because the the copper pennies get extremely warm when soldering resistor leads to them. It will be easier if you solder one resistor, skip the next, solder the next, etc. Be sure to not burn your fingers. With PC board end discs your normal soldering pencil will do the job. When all resistors are soldered through both discs, push up an insulated wire at least five inches long through both central holes in the discs. Strip a bit of insulation off the end of the wire where it exits the upper disc, bend it over, and solder it to the disc very near the central hole.

Using a piece of insulated wire of a different color about four inches long, strip a short length of insulation from one end, and solder this end to the outside of the bottom disc, very near the central hole.

While the dummy load is cooling, place the sleeve on the barrel of a PL-259, <u>but screw it down only as far as will leave one of the holes in the sides of the barrel visible</u>. Now pick up the cool dummy load

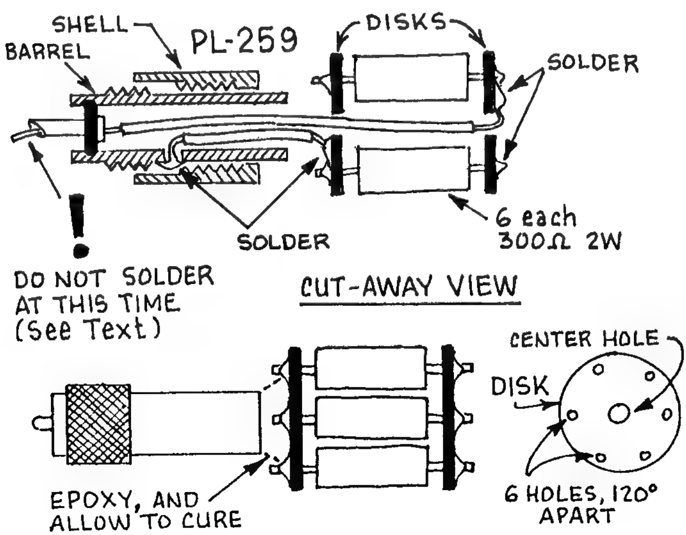


Fig. 1

and slide both wires through the top of the barrel, guiding them so the wire from the central hole extends through the central pin, and the other wire slides through one of the holes in the barrel. Snug up both wires, and with a dab of paint or ink or whatever, mark the insulation where the wire leaves the PL-259. Then remove the dummy load with its wires.

Cut the wire from the central hole a half inch farther out from the point marked on the insulation, and strip one inch of insulation from the wire. Cut the other wire a quarter-inch below the point marked on the insulation, and strip off a half-inch of insulation.

Now slide the wires back into the barrel of the PL-259, making sure each extends out through its proper place, with the dummy load pressed against the PL-259. Pull on the wire extending from the central pin and bend it to one side to hold the dummy load in place. Then bend the wire through the hole in the side of the barrel, shortening it with cutters if necessary, and solder it to the barrel at the hole, using a solder gun. **Do not solder the central pin at this time!**

It will take a while for the PL-259 to cool enough to handle, so relax. A cold 807 might help here. When it is cool, screw the barrel all the way into the sleeve until the sleeve is free and all the way down. Now pull the wire from the central pin wile pushing the dummy load down until the latter is snugly against the top end of the barrel. Now solder the wire in the central pin and clip off the excess, dressing the extra solder off if needed. This completes the dummy load. Measure its resistance between the central pin and barrel, deducting the DMM test lead resistance.

Building the RF peak voltage head is much simpler. See Fig. 2. With minimum lead length, solder one lead of an 0.01 uF disc capacitor to the cathode lead of a germanium diode (1N34A, 1N270, etc.). Clip off only one of the two leads. This lead will connect to the positive lead to the DMM, and this lead can be soldered in

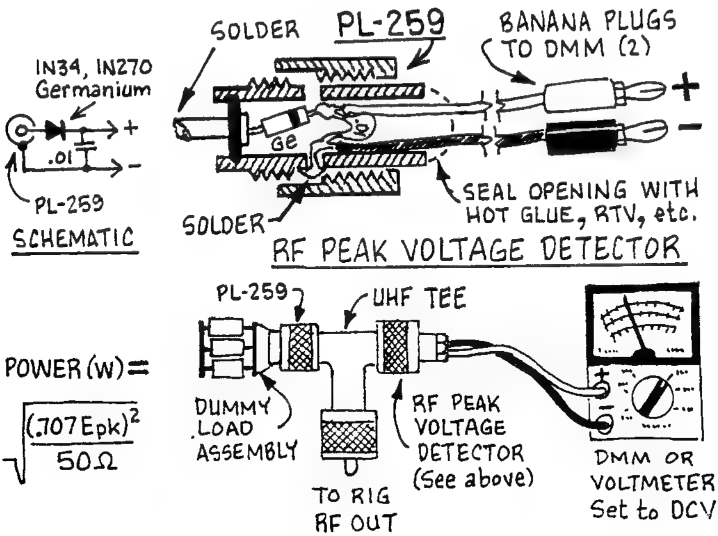


Fig. 2

place now.

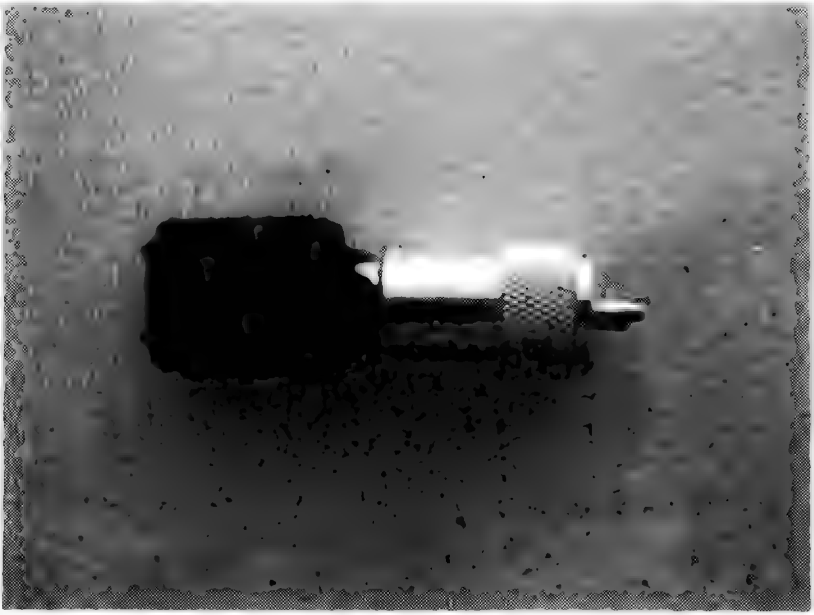
Carefully slide the diode/capacitor assembly into the barrel of a PL-259, guiding the two leads so the diode anode leade extends through the central pin, and the capacitor lead through one of the holes in the barrel. It it is impossible to get the capacitor lead out through one of the holes, it can be brought back up through the top of the barrel and soldered to the rim. Make sure there are no shorts inside the barrel of the PL-259, then solder the dode lead to the central pin, and the capacitor lead either through one of the holdes in the barrel, or at the top of the rim. Then insert the lead which will connect to the negative terminal on the DMM through the barrel and solder it at one of the holes in the side of the barrel.

When the barrel has cooled, slide the sleeve of the connector over both insulated wire leads and screw it down into place on the barrel. Place connectors, usually banana plugs, on the two wires, connectors which mate with your DMM. This comples construction of the RF peak voltage head. [Note you may want to fill the cavity with hot glue, making sure that there are no shorts first of course.]

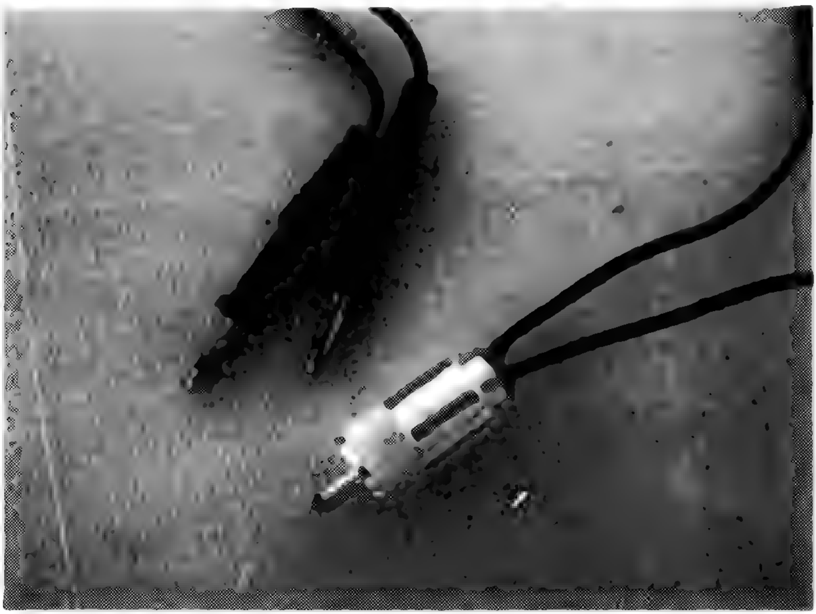
Screw the dummy load assembly on one arm of a UHF Tee connector, and the RF peak voltage head to the other arm of the tee. The male connector will connect to the antenna connector, usually an SO-239, on your QRP rig. Plug the DC connectors into your DMM in place of its test leads, and set the DMM to indicate DC Volts. There will be 22.36 VDC indicated at 5 Watts output when you key the rig, so with most DMMs you'll have to settle for an indication of 22.4 VDC.

To really finish of the job properly, use epoxy to secure the bottom disk of the dummy load to the top of the barrel of the PL-259. Also, to prevent the wires pulling out accidently, use hot glue, silicone rubber or anything similar to close the end of the PL-259 barrel on the RF peak voltage head where the leads to the DMM exit. Doing these two things will make your setup pretty much idiot proof. Enjoy, 72, Frank.

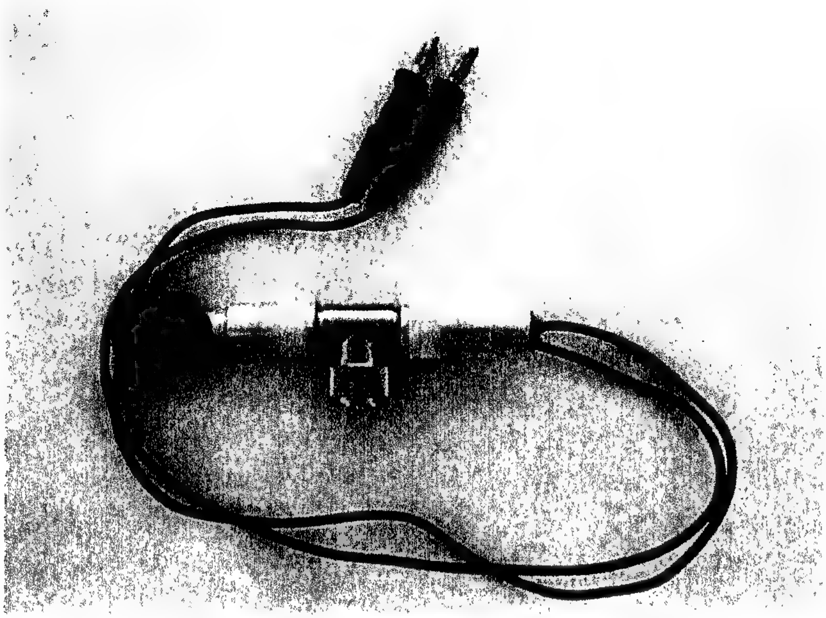
Fig. 3 - Assembly in use



W4LJD Dummy Load



W4LJD Peak Voltage Detector Head



W4LJD "Accurate QRP Power Measurement Assembly"

Bandspread for the Sierra

by Pete Hoover, W6ZH
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This article will show you how to convert either your NorCal or Wilderness (or, if you're like me, both) Sierra VFO from one tuning range covering 150 kHz to three ranges each with slightly over 50 kHz - using just a handfull of passive components. Plus, while an external switch is convenient it is not absolutely necessary.

Why do I have two Sierras (doesn't everyone?)? I have unmercifully modified my NorCal version to include a built-in Curtis keyer, a SWR bridge, the ABX mod, external connections for a DSP unit, plus a number of mods recommended by the Sierra Guru (N6KR, who else??) etc., but the more I read about the Wilderness version and the improvements, I knew I had to have one... the bandspread mod on the NorCal was finished in January, 1997, and the Wilderness kit arrived in mid-February, 1997 and was completed and calibrated on March 1. So - now I have both.

In "stock" configuration, the Sierra tunes 150 kHz using what seems to be a 7:1 reduction in the capacitor tuning mechanism. In other words, 3.5 turns covers 150 kHz which is 42 kHz per turn. Or... about 120 Hz/degree of revolution.

When I added the ABX (variable selectivity) modification to my NorCal Sierra (the Wilderness version had it as standard), this fast rate of tuing became a real problem if the ABX was set at maximum selectivity - a bare nudge of the tuning knob

would send a signal completely out of the receiver pass-band. Or if looking fo rthe Foxii or some other type of careful tuning was involved, an extremely steady hand was necessary. Somthing had to be done!

At this point, it is necessary to point out that the Sierra frequency conversion scheme is the reverse of what you might think. The VFO tunes lower in frequency to tune the transceiver higher in frequency. In other words, at 7.000 MHz the VFO is near its highest frequency (about 3.085 MHz) while at 7.150 MHz it is at its lowest frequency (about 2.985 MHz).

Consideration was given to modifying the VFO circuit to use varactor tuning which would make paooible the use of a 10 turn pot. However, this would require major surgery on the PCB and on th efront panel plus the need for a perhaps scarce varactor as well as more rigorous voltage regulation. Not to mention that some new form of frequency read-out would be needed if a KC-1 or something similar wasn't being used. All this seemed like too radical an approach although I understand that Cam, N6GA, has successfully switched (no pun intended) to varactor tuning on his Sierra, and it sounds good on this end.

Another approach was to stay with the standard capacitance tuning but somehow reduce the VFO tuning range. This brings up several possiblilities: first, install a new capacitor with reduced range, but where would this unit be found - not in my junkbox. Second, plates could be pulled out of the existing capacitor - but if something went wrong this could ruin the capacitor, plus it wasn't a reversible mod. Or third, a suitable capacitor could be put in series with the existing VFO cap and there-by electrically reduce the range. AHAH! That's it!

A little pushing of the HP-12C showed that something around 20 pF or so would be needed in series with the VFO cap, so a nice (old) NPO 5-25 ceramic trimmer was found in the junbox and put in series with the VFO cap, C54. The new trimmer replaces the wire that goes between the VFO cap and the PCB. Remember, the VFO tunes from 2.985 to 3.085 MHz; with the trimmer at about minimum capacitance, the new tuning range was from 3.109 to 3.113 MHz, or about 4 kHz! Too much of a good thing! With the trimmer at maximum, the tuning range was about 45 kHz, starting at about 3.045 MHz. Since a 50 kHz or so range was desired, a fixed cap across the NPO trimmer was indicated.

Without detailing the various experiments, it turned out that a 15 pF SM (silver mica) across the NPO trimmer along with an added 10 pF across the VFO padder (C52) to bring down the maximum VFO frequency gave a trial tuning range of 51 kHz - EUREKA!!

A small on-off-on switch was used to add one or two small air-variable caps across the VFO cap-cum-trimmer. The switch was wired so that the "LO" position used neither of the air trimmers, the "MID" used one, and the "HI" used both airtrimmers in parallel. IN final form these trimmers were set so that the "LO" range (remember, VFO HIGH for transceiver LOW) was 3.035 to 3.096 MHz (61 kHz), the "MID" range was 2.985 to 3.073 MHz (58 kHz), and the "HI" was 2.935 to 2.987 MHz, (52 kHz). On my Sierra (Wilderness, but the NorCal was very close to this), this gave the following (for 40 meters): "LO" 6.989 to 7.050 MHz, "MID" 7.042 to 7.100 MHz; and "HI" 7.099 to 7.151 MHz.

As you see from above, the tuning range of each bandspread segment is not exactly 50 kHz, nor the same range to range. The thoughtful student will realize why (hint - the total capacitance in the circuit changes from range to range but the inductance of L7 does not.)

In setting up the rig after this modification you will find that you will have to

juggle the old VFO padder (C52) and the new trimmers to achieve the desired tuning range; if you initially set the "LO" range to cover about 65 kHz with the 7.050 MHz at the VFO cap fully meshed, and then proceed to the "MID" and "HI" ranges in that order, you should be somewhere near what is desired. You may find that you will have to increase (or decrease) the NPO trimmer so that you can get the desired tuning range on the "HI" segment. With the "HI" range set at just a bit more than 50 kHz, the other tow sements will be slightly more - see above.

The schematic drawings show the before and after of the VFO circuit - which is the same for both the NorCal and the Wilderness versions. Also given are the schematics of two versions fo switches - the on-off-on mentioned above as was installed in my NorCal Sierra and an on-on-on version as used in my Wilderness Sierra modification. The on-off-on switch goes from "MID" to "LO" to "HI" while the on-on-on provides the expected "LO", "MID", "HI" configuration. However the on-on-on miniature switch may not be easily available.

As the photos show, I chose to put the bandspread switch on the front panel of both the NorCal and Wilderness Sierras. In the case of the Wilderness version it was a real chore as space was very limited (see Photo 4), but there wasn't all that much space in the NorCal version either. (Photo 2).

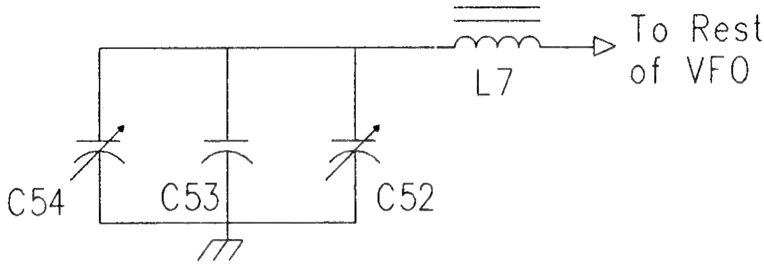
In both versions, I used a small piece of Vector board to hold the air trimmers. Thjis was epoxied to the bottom of the switch (don't forget to rough up both the switch surface and the Vector board so that the epoxy gets a good "grip"). In both cases, the NPO trimmer was fastened to the back of the VFO cap using the already threaded hole. None of the photos show it, but C56, (the SM across the NPO), is soldered directly across the bottom of the NPO. #18 tinned wire was used in wiring up the mod to make sure that there would be no frequency change due to vibration, etc. Check the switch schematics to make sure that you have the correct air trimmer attached to the correct switch contacts!

If a "no-hole-in-a-panel"installation is desired, a small bracket holding the switch, the trimmers, etc., could be mounted on the back of the VFO capacitor utilizing the already threaded holes (make sure the screws don't hit the capacitor plates!). Since the cover has to be removed anyway to change bands, this wouldn't represent much of a chore to change the desired bandspread at the same time - or just to change the segment of the same band. For example, 20 meter DX to 20 meter QRP. And, it's neat to have the 30 meter band cover about three turns of the dial instead of one plus being able to quickly check WWV with jsut a throw of a switch!

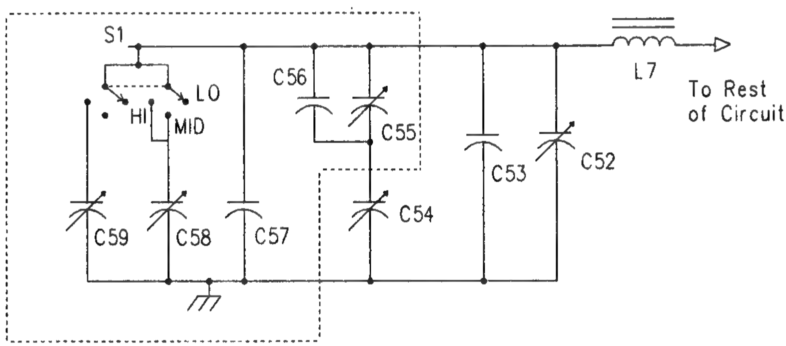
Dial calibration? The Wilderness Sirra (Photo 3) has a KC-2 (highly recommended), so that eliminates that problem very nicely. As Photo 1 shows, I have a not-yet-completed new dial on the NorCal Sierra. When it is finished (someday!) it will be most adequate.

There it is - a method of bandspreading your Sierra so that the tuning rate is more in keeping with the available selectivity. Does it work? You bet. Now instead of 42 kHz/turn it's 14, or about 39 Hz/degree of rotation. It it mechanically and electrically stable? Yep. I took my Wilderness Sierra on a swing through Hawaii, Guam, Saipan, and American Samoa. I had at least one QSO in each call area, but that's a different story. The rig's calibration remained right on, the signal was stable, and with the ABX at maximum selectivity, it was a joy to use.

Any questions, let me know. Email is best at w6zh@ix.netcom.com. 72, Pete, W6ZH



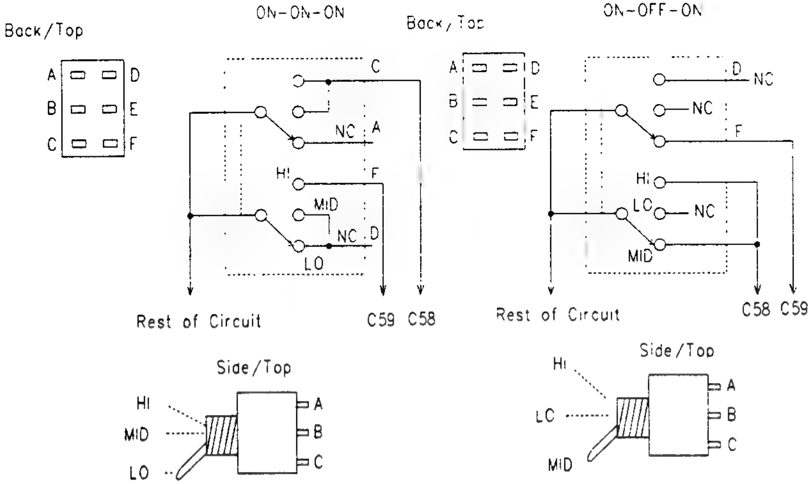
Frequency determining components of VFO before modification
Tuning Range 2.935 - 3.085 MHz



Modified VFO Circuit
New Components Shown in Dotted Line

New Tuning Ranges:
LO = 3.035 - 3.096
MID = 2.985 - 3.073
HI = 2.935 - 2.987
C52, C53, C54 - Unchanged
C55 - 5-25 pF NPO (Mouser 242-3610-12 @ 2.0 - 12.0 pF is close enough)

C56 - 15 pF Silver Mica
C57 - 5 pF Silver Mica
C58, C59 - 2 - 24 pF air trimmer (Mouser 530-189-0509-5)
S1 - Either ON-ON-ON (GC-35-009) or ON-OFF-ON (GC 35-012)



Toggle Switch Detail

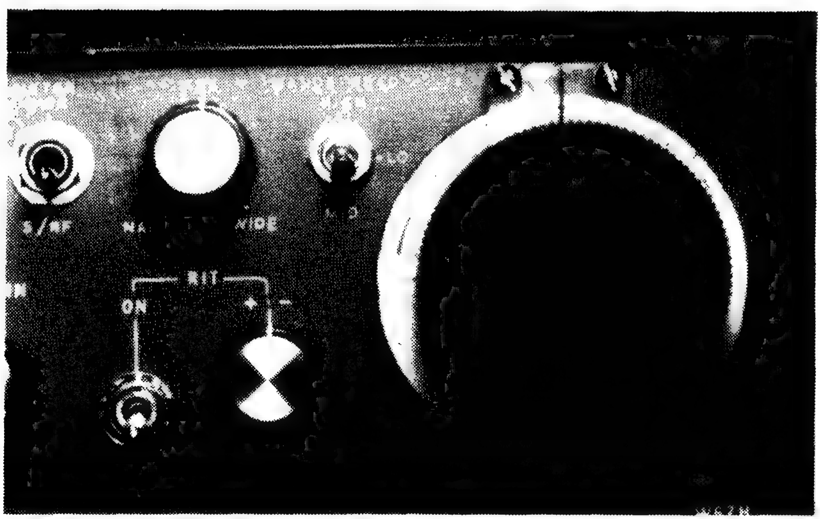


Photo 1 - NorCal Sierra Front Panel with Bandspread Switch
W6ZH Photo

Photo 2 - W6ZH NorCal Sierra Added Components for Bandspread Circuit
W6ZH Photo

Photo 3 - W6ZH Wilderness Sierra with Added Bandspread Switch
W6ZH Photo

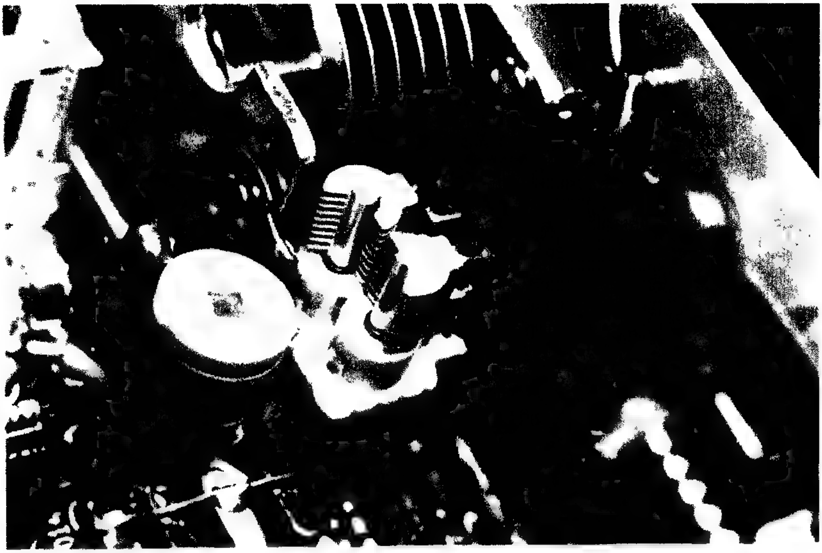


Photo 4 - W6ZH Wilderness Sierra with Added Components for Bandspread Circuit, W6ZH Photo

Bandspread Tuning for the 38 Special (Plus comments on the Thump Fix)

by Dan Winkler, N7IVR

There is one solution to tuning the 38S that I don't believe has been mentioned: a bandspread tuning control. Radio Shack sells a 100k dual audio taper pot (about $2). If you connect one side of the dual pot (pot A) to (+8), and the other side of the other half (pot B) to ground, and then connect a smaller (5K) pot between the wipers of these two (A and B) 100k pots, you will effectively be able to "move" the 5k pot up and down the 8v tuning range. The 5k pot will have about 0.4 volts across it, which should really spread out those signals.

I have sullied my (previously virgin) 38S board. Half the components are in place. With all the mods it has been slow going. (I keep adding and measuring and changing stuff!) In building up the board, I discovered some problems with my proposed fixes for the thump.

The first involves the "virtual inductor", or isolating transistor for U3. U3's power supply needs to be quieted. I suggested breaking the power supply line to U3 by cutting the fine traces going between the pins of U2. This turns out to be a real pain in the... (I did it, but ...).

I suggest cutting the thicker trace distal to that comb of fine traces (distal is a medical word- means farther away from some central reference point). Probably the best spot is just proximal to C44, the 0.1uf bypass cap for U3 (proximal means closer to the center - the opposite of distal).

The second error is minor. I said to isolate U5-A from U5-B by cutting the trace just to the left of U5, before it hooks up with R19. Well, you guys already caught the fact that it's R21 over there, not R19. But did anyone notice that this trace also goes to C34? C34 is supposed to feed high frequency audio back from pin 7

(U5-A output) to pin 6 (U5-A (-) input). When done as described, my mod will change the feedback path of C34 slightly: it will go from the INPUT of the U5-B section (which is R21, 510 ohms), back around to the (-) input of U5-A. So we have a little extra in series with C34's feedback path, namely: the 85 ohms of the U2 channel (switch) resistance in series with the 4.7uf tantalum cap you added from U2 to R21. My modeling program shows this makes no difference whatsoever. However, I didn't think this all the way through while building my 38S, so I removed C34 and piggy-backed it across R20 (where it logically belongs). No harm done, as it left the space for C34 open, and I added some more junk there.

Dan Winkler N7IVR Seattle WA

The Devil Made Me Do It
or
How I Got Myself Into Trouble and It's All Doug's Fault.

by Michael A. Gipe K1MG

It all started last fall at Pacificon. I should have seen it coming, but trouble doesn't always come with neon warning signs. I walked into the lobby of the hotel where Pacificon and the QRP forum were being held, and I saw Doug sitting there with another ham. I went over to say "Hi" and Doug introduced me to Derry Spittle. Doug and Derry had been talking about Derry's latest radio design, and Doug said, "Mike, do you know how to program those little microprocessors?" I replied, "Yes", a little tentatively, not sure what the next question would be. He asked, "Could one of those be used to build a frequency counter that you could use to display the VFO frequency of a homebrew radio?" I said, "No problem, that would be easy to do." If you've ever talked to Doug before, you would realize that alarms should have started going off in my head. Doug has an enthusiasm for all things QRP and homebrew that infects other people like a virus. Before I left the lobby, Doug had extracted a promise that I would think about how I would implement a suitable frequency counter.

When a cold virus attacks your body, it starts multiplying exponentially until it overwhelms all your body's defenses, and you feel like you've been hit by a Mack truck. Well, after my conversation with Doug, the frequency counter design was rolling around in my brain during the remaining seminars at Pacificon. During the drive home, I was thinking about subroutines and LCD displays and eproms. By the time the next NorCal meeting rolled around, I had worked out most of the details of how I would implement the counter.

At that meeting, Doug came up to me and asked how the design was coming and when NorCal would be able to kit it and how much the parts would cost. Feeling a little like I was sliding over the edge of the tiger trap, I told him that I could put together a counter with a four digit LCD display that would have programmable offsets for multiband rigs. It would work with VFOs up to 30 MHz and — at this point, the engineer in me overcame all rational caution — and it would also have a built-in 24 hour UTC clock! He smiled and asked, "Could it be built for less than $30?" I stuck my neck out and said, "Sure!" Of course, I thought he was smiling because he liked the features of the design, but now I realize he was smiling because he knew that he had me hooked.

By the next NorCal meeting, I had breadboarded the circuit and written most of the microprocessor software. I brought it to the meeting for show-and-tell. Doug came over to me and said, "You know

Mike, we're up to our eyeballs trying to get these 38 Special kits out. A smart guy like you could kit up this great design real easy. You could sell the kits yourself and be famous." For some odd reason, I kept seeing scenes from the show, "Damn Yankees", but I just didn't make the connection at the time. When I got home from the meeting, I knew I was in trouble, but I was committed.

So, for the next couple months, every spare minute was consumed by the Digital Clock/Counter. I tweaked the software, tested the breadboard with the 38 Special, designed a PC board, built several prototypes, collected parts, wrote a manual, and put together several kits for beta test. Finally, it was ready to sell.

So now I'm selling kits, ordering parts, sorting them into envelopes, shipping them out, and helping people test them. After counting out the 10,000th resistor, I asked myself, "How did I get myself into this?" It was then that I realized I had been overcome by Doug Hendricks' enthusiam for the hobby. I was infected, and after seeing some of the first kits built, I realized there was no cure.

So that's how I got myself into trouble making ham radio kits, and it's all Doug Hendricks' fault!

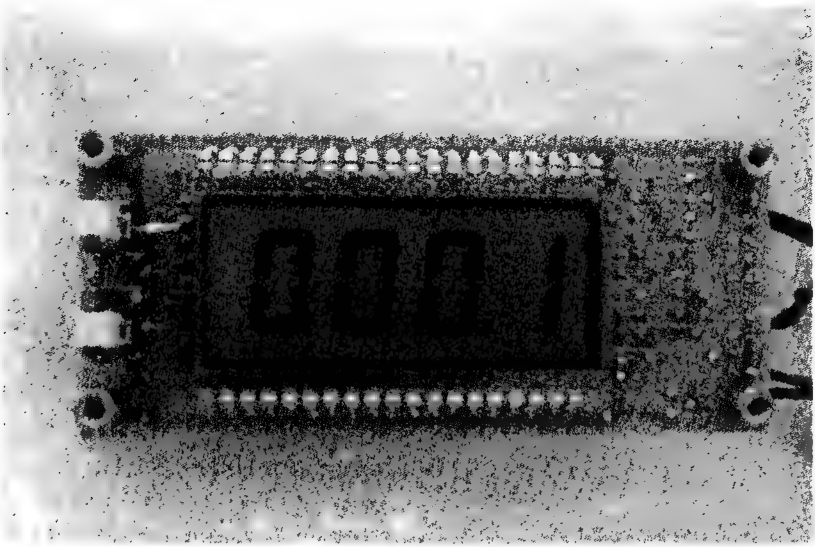
The K1MG Digital Clock/Counter

by Michael A. Gipe K1MG

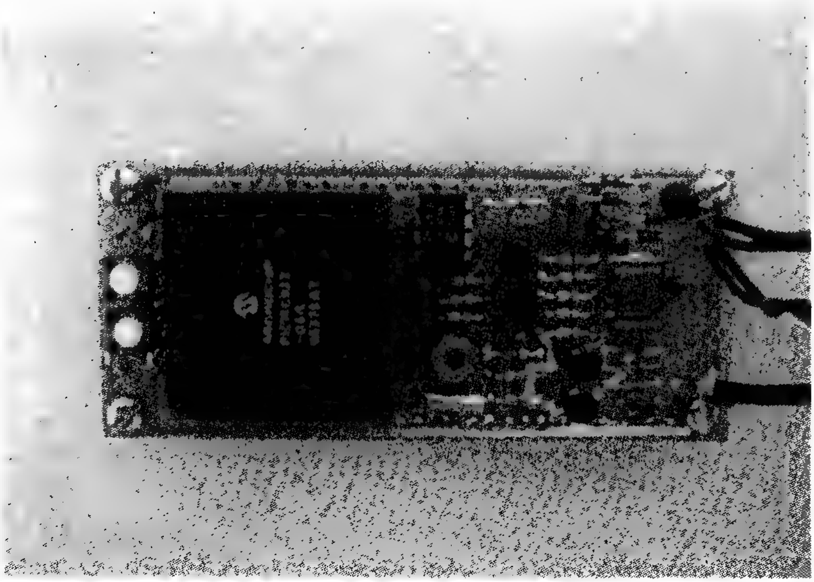
Many modern QRP radios are marvels of efficiency and performance with highly stable VFOs or VXOs, sharp cutoff crystal filters, and low-noise high dynamic range receivers. However, in the interests of size, power consumption, or cost, many of these rigs do not have a precise way of determining the operating frequency, often relying on hand calibrated markings around the front panel tuning knob. To satisfy the need for an accurate digital readout of operating frequency, I designed the Digital Clock/Counter. This makes it easy to add a digital readout to homebrew or kit radios without compromising the cost, size, power consumption, price, or performance of the radio.

With so many constraints on the design, I knew I would have to make a few parts do a lot of work. Small size and low cost were both important, even though these are sometimes conflicting requirements. The counter would have to use an LCD display, because the power consumed by LEDs would be more than the rest of the radio! MicroChip Corporation had recently announced a new addition to their line of PIC microcontrollers, an IC that had a reduced instruction set microprocessor and a built-in LCD controller. Although more expensive than most of their other PIC microcontrollers, having several functions in one IC would have size and power advantages. Unfortunately, computers and radios are like cats and dogs — they don't always get along together. Microcomputers tend to generate lots of RF noise, and when you put one inside a sensitive radio receiver, it plays havoc. Although you can put lots of shields around the computer and bypass all the inputs and outputs, the best way to eliminate interference is to run the processor at extremely low frequency and low current. The less radio frequency energy you generate, the less you have to get rid of. I decided to run the microprocessor with a 32.768 kHz clock, because inexpensive but stable clock crystals were available at that frequency.

That being decided, the idea of also using the microprocessor to implement a 24 hour UTC clock was natural. Everytime I operate a portable station, I don't have space to carry a UTC clock, so I'm forced to use my wristwatch and do a mental UTC conversion. I hate to admit how many times I've missed the start of Field Day for that reason! It would sure be nice to



K1MG Digital Counter/Clock Kit Front View



K1MG Counter/Clock Kit Back View

have a clock built right into the radio.

Of course, running the microprocessor with a 32 kHz crystal has quite a few limitations. First of all, you can't do a lot of processing in one second. Compare the speed of a 266 MHz Pentium with a 32 kHz PIC and you realize you've got to make every instruction count. Secondly, the low processor frequency imposes some severe limitations on external inputs — like the signal you are trying to count. I wanted to be able to count the frequency of signals up to 30 MHz. By reverse engineering the innards of the PIC, and confirming some ideas with Microchip's applications engineer, I was able to come up with a scheme to accomplish that goal, although it does take some pretty involved steps to do it.

After going through those steps to measure the signal frequency, the DCC adjusts it for mixing offsets and displays the radio operating frequency with 100 Hz resolution. The four-digit liquid crystal display (LCD) is used in conjunction with a "MHz" shift pushbutton to show six digits of frequency. For example, 10.116400 MHz appears normally as 116.4, precisely showing the position within the ham band. Pushing the "MHz" button shifts the readout to show 10.11 MHz, instantly identifying the spot within the HF spectrum.

The clock function runs in the microprocessor software at the same time. To see what time it is, you just press the "Clock" button and the LCD shows the time in 24 hour format. Of course, the only thing worse than not having a clock is having one which forgets the time whenever the power is turned off! For that reason, I put in circuitry to run the clock portion of the DCC off a lithium battery whenever the normal power is removed.

Except for direct conversion transceivers and direct CW and AM transmitters, most radios use a VFO or VXO which spans a different frequency range than the actual on-air operating frequency. The VFO output is typically mixed with one or more local oscillators or beat frequency oscillators to convert from audio to RF and back again. The DCC has provisions for adding or subtracting the measured VFO frequency from a programmable fixed offset before the value is displayed. For example, if the VFO at 4.9 MHz is mixed with a local oscillator at 9.2 MHz to produce a 14.1 MHz transmitted signal, the DCC can automatically add this local oscillator (LO) value to the measured VFO frequency to display 14.1 MHz. This feature can also be used to accurately display receive and transmit frequencies, taking into account any transmit/receive offset, RIT, or XIT. To accommodate these offsets for each band of multiband rigs, up to 31 offset values may be programmed into the DCC. Each can be programmed for additive or subtractive offset. These are selected by digital signal inputs to the DCC. The offset values are stored in nonvolatile memory so that they are retained even when power is off. Nearly any superhet mixing scheme can be accommodated except where the VFO frequency is multiplied or when it is above the upper operating frequency limit of the DCC. In these cases, it may be possible to supply the DCC with a signal further along the signal chain, after the multiplier or first mixer, for example.

To keep the cost low, I decided to put all the circuitry on one PC board, even though space behind the front panel is pretty limited in most radios. To conserve space, I put components on both sides of the board, which was possible since there is a lot of clear space under the LCD. Although you might think that assembling a board with parts on both sides would be difficult, if you install the parts in the right sequence, the DCC is not hard to build.

The microprocessor, of course, requires its inputs to switch between ground and the 5 volt supply. Most VFOs put out very low signal levels, are AC coupled, and

don't like to see any additional loading on their output. This meant that a buffer amplifier was required, so I designed one with enough gain that the frequency counter will work with an input as low as 100 mVRMS, or -13 dBm, over the full input frequency range. It also has a fairly high input impedance of 1k ohms, so it won't load down the VFO. Unfortunately, Miller Capacitance is a fact of life, like taxes. Therefore, I had to use a little more current than I would like to run the buffer. The DCC typically requires about 10 mA of power from an 8 to 16 volt source. However, if you don't need full sensitivity at the highest frequency, you can change a few component values and reduce the operating current. The first part of the buffer is a common emitter/emitter follower circuit with feedback. This provides a controlled input impedance and the necessary DC offset. This is followed by a complementary pair driver. Sensitivity is good enough to measure the frequency of your QRP transmitter off the air with just a few inches of wire on the DCC input for an antenna.

The result is an easy way to add a digital frequency display to almost any radio without requiring a lot of power, money, or space. And the 24 hour UTC clock is a nice bonus. Once you add a nice digital display to your QRP radio, you wonder how you ever lived without it!

DCC kits are available from Blue Sky Engineering Company, 400 Blossom Hill Road, Los Gatos, CA 95032. For a short time, they are available for the introductory price of $29.95 plus $4.05 shipping and handling. California residents must add $2.81 sales tax. More information is available on the web site: BlueSkyEngineering.com.

FYBO '97 REPORT

by Joe Gervais, AB7TT
vole@primenet.com, AZ ScQRPions (Phoenix)

It was a blast all around! Now that the snow has settled, the results of the first FYBO Winter QRP Field Day are in. The most common soapbox comment was "had a great time", which makes us ScQRPions very happy. Having a good time is what FYBO was supposed to be all about.

Many thanks to all the field ops who braved the cold, and to the home ops who passed out so many QSOs to the frozen critters in the field. It helped make the cold hours pass faster. :-) And thanks also to the FYBO prize sponsors. You all made a unique event downright fun!

Notes:

- From the 81 logs received, 2321 QSOs were reported - Yowza!
- Coldest field "low temp" was KI0G (10F), warmest field "low" was HP1AC (83F). Somebody owes someone a beer.
- 3 "monster" stations worked over 100 QSOs each (KI0J, N4BP, K0FRP).
- Four of the Top Ten scores were operating QRPp.
- 11 field stations operated in below-freezing temperatures.
- Only "home" ops recommended that FYBO run longer than 12 hours.
- Only two N/T+ logs were received (N3XRV/T, NL7QT/T). Thanks to both of them! Hope to get more N/T+'s on the air next time.
- One DX station joined in the fun (HP1AC).
- Weirdest Soapbox Comment: Brian, KV9X (see below).

Awards/Prizes:

- Highest Score:

MultiOp: K1OJ, 129,600 pts.
Single Op: N0TU, 67,200 pts.
N/T+: N3XRV/T, 2,400 pts. (VibroFloyd Paddles - Thanks NQ7X!)
HB Rig: N0TU, 67,200 pts. (NA5N's QRP Data Book - Thanks

NA5N!)

- Worked Most ScQRPions: K1OJ, 14 (SW-XX QRP XCVR Kit - Thanks WA5WHN & NN1G!)
- Random Drawing: N1MVU (TenTec QRP XCVR kit - Thanks ScQRPions!)
- Coldest Operating Temp: KI0G, 10F (Complete Bound Set QRPp - Thanks NorCal!)
- Worked Most N/T+'s: W4ED, 2 (NA5N's QRP Data Book - Thanks NA5N!)

That's it! Comments and full results follow below, sorted by temperature of course. These results can also be found on ScQRPion Bob's (KI7MN) web page <www.dancris.com/~ki7mn/>. Great job everyone!

Any mistakes are my own. Some scores were corrected (all but one increased, mainly due to method of using multipliers). Thanks again to everyone from us ScQRPions!!! So what do you say, try it again next year?

Cheers de AB7TT,

FYBO '97 SOAPBOX

The monkeys started howling once the antenna was up and kept me entertained during the slower hours. -KV9X, QTH: WA (Note: Brian claims he was operating at a zoo. You are free to draw your own conclusions.)

This was a great idea! ... Called it quits when the snow began. Too bad it was so warm - didn't make the x6 multiplier. -AA0SM, QTH: MN

What a blast! I backpacked about 4 miles and found a beautiful site just below a ridge overlooking Idyllwild and the Hemet/San Jacinto Valley... I froze alright, even with my +15F down bag, fleece liner, 2 ground pads and tent ... the nightime low was 22F. Great contest. Really had fun! -AC6XK, QTH: CA

Sorry for the sloppy logs. Try writing with gloves on at 15F. -N0TU, QTH: CO

Wish I could've gone outside ... but the wind was howling here in WNY ... It sure was neat working guys in the outdoors sending those wicked cold temps. -N2VPK, QTH: NY

Nomination for "Numbest Fist Worked" goes to AA8LF, at 18F. Hats on to him! -N7RI, QTH: VA

The operating post was established in the front seat of (AA8LF's) station wagon. We dressed warmly, and didn't run the heat until late in the evening. -AA8LF & KB8ZQZ, QTH: MI

Needs to run longer, maybe Sunday too. -AB7MY, QTH: AZ (Note: Gary's low temp was 60F :-)).

Accidentally set up in a poison oak thicket. Have lasting memories of our FYBO outing (scratch scratch)! Healed up now, ready to go again. -N6WG & WA6NAE, QTH: CA

Took 3 hours to warm up at home. Lots of stations on the air. -AE0Q, QTH: CO

Stayed nice and warm in the shack. Tried Novice band but no go for N/T's. -K0FRP, QTH: CO

Enjoyed the contest! -K4GT, QTH: GA

Great idea - should have opened the window of the shack - will try for field op next year! -K6MW, QTH: CA

At 8pm we had about 35 QSOs each, and decided to bag it ... Properly freezing at 28F, we called it a night and crawled off to bed. I think I first felt my feet again at about 6am. -KB6FPW & N6CNY, QTH: CA

This is my first contest entry ever, hope to do this again. Alot of fun!! -KB7QXY, QTH: AZ

This was my first (contest) since 1963! ... Thoroughly enjoyed the experience - and I will be back!! -KB9LCK, QTH: IL

Operated from White River National Forest, near Sunlight Ski Area (9,000 ft +/-). -KI0G, QTH: CO

KC7SXW and I camped at 7000 ft

on a ridge ... temp dropped to 22F both nights. ScQRPion Mike (NQ7K) wimped out and spent the night in a hotel with his xyl, but he brought us Pop Tarts and hot chocolate, so we let him off the hook. -AB7TT, QTH: AZ

Went over to one of the local parks along with Vic, K2VCO, and we set up our gear there ... When we arrived it was foggy and about 45F ... When the wind came up, moved into the sun! -KN6YD, QTH: CA

Great fun! My shack, in the garage, is always cold. It stayed pretty much at 57F all day! -KQ6FR, QTH: CA

I was only able to work the contest for a few hours, but they were busy and lots of fun. I drove my van onto a frozen lake and ran a IC-735 at 5 watts to Hamstick mobile antennas ... Temp was 24-26F.-N0UR, QTH: MN

The xyl made me move the shack into our unheated basement last summer ... Well if you all can FYB'sO outdoors in Feb, I guess I can stand to operate in the basement! -N1MVU, QTH: NH

Thanks for the great time in the test ... I tried to open the window to get the temp down 1 degree for the bonus points, but it wouldn't open. Next year it will be outside. -N2TNN, QTH: NJ

Had a blast! Never really "froze" though. -N3XRV, QTH: MD

Had fun!!! Still thawing out! -N4KN, QTH: TN

Wish I could've worked more of the contest, or maybe it should be "funtest". -N4ROA, QTH: VA

I have participated in many contests before but this is the only "log" I've ever submitted ... Let's do it again. Next time I'll be in the field. -N7NX, QTH: UT

Didn't get to the field, but still wanted to make a few QSOs. -W3TS, QTH: PA

NEXT YEAR... PHASED VERTICALS!! -W5VBO, QTH: AZ

Had a great time! Next time will try QRPp! -W5FN, QTH: TX

Temp was 54F to 60F. Hamshack in unheated basement. -W7CNL, QTH: ID

Nice small contest. Only wish I had more xtals to use as I could have done better! -WA2BQI, QTH: NY

Tnx - Great fun! -WA8GHZ, QTH: TX

Could only work the last 30 minutes of the contest. Next year, yeah, that's it. Next year. -WB4ZKA

Had a great time ... Looking forward to next year. -WD8RIF, QTH: OH

280 points - Wow!!! :-) -WJ4P, QTH: SC

A great idea, I hope it's repeated again next year. -WO7T, QTH: AZ

I hope next year I can kick a hole in the snow and operate from the field, HI. -WU7F, QTH: WA

Operated from the back porch. We were upset that the wx Saturday was very warm, and the temp was going to drop on Sunday! -N2MN & N2EAA, QTH: NY

Great contest but what a day! New antenna came down 5 mins after it was put up! ... Then came the expected cold front but didn't expect the lightning with it!! ... Had to move from the backyard to the barn because of rain ... Had fun! -NG1G, QTH: VT

This is a fantastic event. We had alot of fun! -WS4S, QTH: TN

First contest using the Knightlites NEW callsign: WQ4RP - GREAT FUN!!! - AA1BK/AA4XX/N3GO/WA4NID, QTH: NC

Radioactive Camping and Contesting Club (RACC) K5RAC ... Had a great time! ... Let's do it again soon! -N5YAK/KK5NA/N3BUO/KK5QA, QTH: TX

I did FYBO from the snowy mountains of northern Idaho. I cross- country skiied about a mile, dug an operating pit, and sat in it and did radio for 9 hours ... Not many contacts, but great scenery and a wonderful way to spend FYBO. -AB7TK, QTH: ID

I just got on to hand out a few points. After working AB7TT's low temperature,

I was too embarrassed to continue. :-) -KB9IUA, QTH: IL

We saw a little of all types of wx...blinding, stinging rain, beautiful blue skies, windy-rough water. All in all a great weekend under the sky! :) -KF4KRV, QTH: AL

I have been on the air once since Field Day ... So getting on at all was something of an accomplishment. -N7IVR, QTH: WA

The portable operation was scrubbed for FYBO due to 40++ MPH winds with gusts of 80+ MPH!! Lots of fun anyway. -WB2VUO, QTH: NY

Had a power outage at 2100, and only able to work 1 station with the Sierra and battery power. A fun time, maybe next year I'll head outside. -WZ2T, QTH: NY

FYBO '97 RESULTS

Sorted by lowest operating temperature, naturally.

NOTE: Number of actual QSOs are listed, not QSO points. (*) indicates Multi-Op.

Callsign	Location	Q's	SPC	Temp	Score	Power
KI0G	Field	9	5	10 F	2160	2w
N0TU	Field	35	20	15 F	67200	950mW
VE3JC	Field	44	23	18 F	13386	5w
AA8LF (*)	Field	58	28	19 F	43008	990mW
AA0ZR	Home	23	8	20 F	1840	4w
AA0XJ	Home	8	8	22 F	680	5w
N0UR	F/H	57	28	24 F	45800	5w
AA0SM	Field	23	16	27 F	14720	2w
KB6FPW	Field	35	15	28 F	44400	950mW
N6CNY	Field	32	16	28 F	42240	900mW
AC6XK	Field	15	8	28 F	9280	2w
AB7ST	Field	8	6	29 F	1920	5w
AB7TT	Field	92	33	29 F	124080	5w
WS4S	Field	44	21	30 F	29568	5w
NG1G	Home	44	27	30 F	9504	5w
AB7TK	Field	9	5	34 F	1440	2w
AE0Q	Field	65	29	36 F	60160	5w
N7IVR	Field	2	2	38 F	128	5w
KC7SXW	Field	6	3	39 F	576	5w
W5BI	Field	25	13	41 F	7800	4w
KV9X	Field	32	15	42 F	11520	4w
WD8RIF	Field	11	7	42 F	1848	5w
K4NK	Home	24	15	42 F	1080	4w
WA5WHN	Field	52	26	43 F	32448	5w
N3XRV/T	Field	5	5	43 F	2400	950mW
WQ4RP (*)	Field	67	30	44 F	48240	2w
N4KN	F/H	10	9	45 F	1185	5w
KN6YD	Field	6	4	45 F	84	2w
N4EO	Field	27	14	45 F	9072	5w
N2MN (*)	Field	12	8	45 F	3456	5w
KF4KRV	Field	7	6	47 F	1008	2w
K1OJ (*)	Field	150	36	48 F	129600	5w
WA8GHZ	Field	34	19	48 F	15504	5w
W4ED	Home	53	26	48 F	11232	5w

Callsign	Location	Q's	SPC	Temp	Score	Power
K5RAC (*)	Field	12	8	49 F	3072	4w
W5FN	Field	39	19	50 F	11856	5w
WB2VUO	Home	18	11	51 F	792	5w
W5VBO	Field	27	14	52 F	6048	5w
W7CNL	Home	26	19	54 F	988	5w
N6WG (*)	Field	82	32	55 F	41984	5w
KB9LCK	Home	17	13	55 F	402	3w
WB4ZKA	Home	6	5	56 F	240	950mW
KQ6FR	Home	24	13	57 F	624	5w
AB7OA	Field	13	9	58 F	1872	5w
KI7MN	Field	17	10	59 F	3360	2w
N9UKX	Home	9	9	59 F	162	4w
K2VCO	Field	19	14	59 F	4256	5w
AB7MY	Home	33	17	60 F	561	5w
N2TNN	Home	17	12	60 F	408	5w
W3TS	Home	12	7	60 F	336	900mW
KC1FB	Field	3	3	60 F	288	950mW
N7RI	Home	13	12	60 F	156	5w
KB7QXY	Home	11	5	60 F	120	5w
N1MVU	Home	8	7	60 F	56	5w
K6MW	Home	10	5	60 F	50	3w
K4GT	Home	19	11	64 F	209	3w
K5JS	Home	20	13	65 F	260	5w
KG0ZT	Home	18	13	66 F	598	5w
K5OI	Home	30	14	68 F	1680	950mW
K1MG	Home	52	28	68 F	1456	5w
N4BP (*)	Field	126	40	70 F	40640	5w
N7NX	Home	22	15	70 F	660	2w
WO7T	Home	21	14	70 F	294	5w
NL7QT/T	Home	11	3	70 F	132	5w
K3WWP	Home	10	7	70 F	70	5w
KB9IUA	Home	8	7	70 F	56	5w
W7GVN	Home	12	8	70 F	96	2w
WA2BQI	Home	4	4	70 F	16	1w
WJ4P	Home	10	7	70 F	280	950mW
WZ2T	Home	50	18	70 F	900	5w
AE4IC	Home	13	7	71 F	182	5w
N4ROA	Home	88	33	72 F	6072	5w
K0FRP	Home	125	36	72 F	4572	3w
N2VPK	Home	37	21	72 F	3728	950mW
WU7F	Home	20	15	72 F	600	5w
KB5HRS	Home	14	10	72 F	140	5w
AL7FS	Home	4	4	72 F	16	5w
K5ZTY	Home	25	16	75 F	400	5w
AC6KW	Field	4	4	75 F	128	3w
AA1IK	Home	17	13	75 F	221	5w
HP1AC	Home	23	16	83 F	368	5w

Building the TiCK 2 Keyer Surface Mount

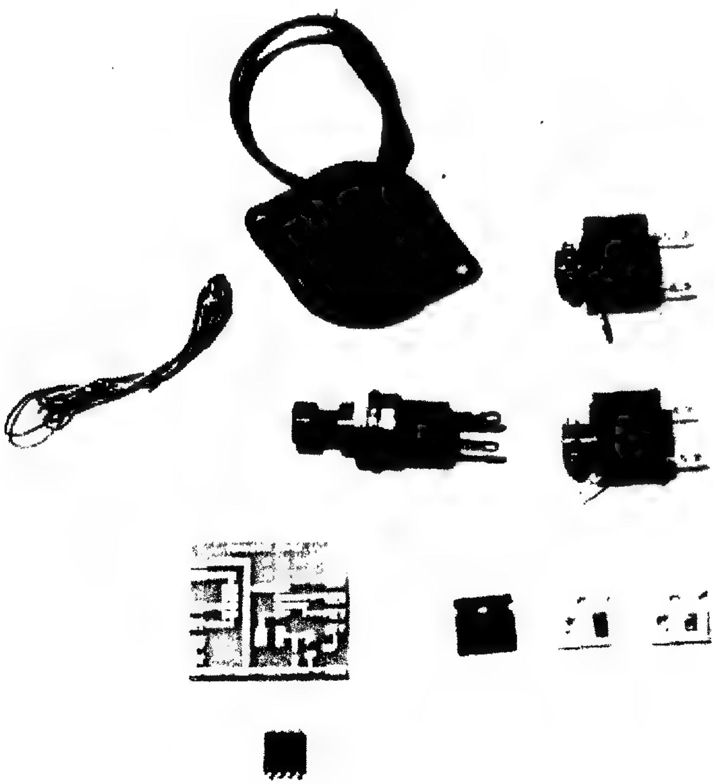
by Darrel Jones, WD6BOR

I just finished up the TiCK Memory Keyer, SURFACE MOUNT EDITION, that Doug brought back from Dayton as my building contest prize, and I must say it was a real pleasure to build.

I was all set to tell everyone about having to steal my granddaughter's microscope and my wife's tweezers to put this kit together, but I am worried someone might take me seriously. As if anyone who knows me would do that. I did use my magnifier/light and another magifying glass to identify parts, but anyone with good eyesight wouldn't need to do that.

Embedded Research put this kit together as a surface mount learning experience. To that end they included a very detailed six page manual with large, clear, well detailed illustrations and a comprehensive step-by-step building guide. I had built their Atomic Memory Keyer as well as TiCK 1 keyers in 38 Specials as well as one stand alone, and have found their instructions always done to the same high level standard.

The kit is furnished with a single sided (naturally) glass epoxy board with all the traces already tinned. There are only four surface mounted parts, including the eight pin IC chip and one each capacitor, resis-



Embedded Research's TiCK 2 Surface Mount Kit

tor and transistor. If you've already built a standard TiCK 1 or 2, you already know what a simple board it is. The complete unit consists of the chip and keyline transistor with series resistor and bypass capacitor, two wire keyline jack, three wire 3.5 mm (stereo) paddle jack, momentary normally open push button switch, audio output (with a piezo audio transducer supplied with the kit for built-in sidetone) and your choice of a power connector that you furnish.They even include a coil of solder as part of the kit.

As is usual, "stuffing the board" took the least amount of time. Shakey as I am at the end of the day, it took less than 15 minutes to prep and solder the components and leads to the board. The folks at Embedded Research even made the pad larger than usual for surface mount construction to make it possible for a first time SMD builder to make the rig fire up right off the bat. If you have a habit of dropping parts you shouldn't worry because they furnish two each of the capacitor, resistor and transistor "just in case". The jacks, piezo and push button soldered up in just a few more minutes.

I spent the most time adapting a Radio Shack AA battery holder to fit a DL123A 3 volt lithium camera battery. After working out the details with theAtomic Keyer, I just cut two 1/2" by 1/2" squares of printed circuit board and soldered the power leads from the keyer to each one. I then cut a piece of 3/8" wooden dowel 3/8" long and shimmed the battery into that. Although I had installed a switch in the Atomic Keyer, I didn't even bother with the TiCK 2 because when it is not in use it goes into "sleep mode" and draws about one microamp of current. Any power source between 3 and 5 volts will work.

Probably the biggest problem facing me was finding an enclosure SMALL enough for the TiCK 2. An Altoids tin was ruled out right away because it was just too cavernous (and because I had already put the Atomic Keyer into an Altoids tin). I finally settled on one of my preciously hoarded Celestial Seasonings tins only because they are so pretty and I hadn't put anything into one yet. After drilling the tin for the jacks and switch, I took Doug's suggestion and simply epoxied the board to the top of the jacks. Looking over the finished product, I'm left wondering what to do with all the left over space inside the tin. Maybe a 386 audio amp to boost the sidetone.

Programming the TiCK 2 is just like the TiCK 1, with the exception of the ability to store a message of up to 20 to 25 characters. The push button is held until the code letter for the function desired is heard. Some of the functions include speed set, memory input and playback, tune mode, Iambic A and B mode, and sraight key mode, as well as a couple others. The programming takes about 30 seconds to learn after which you'll spend from several minutes to a couple of hours playing with it.

I bought a TiCK 1 with a board when I ordered several other TiCK chips to go into some 38 Specials I'm building and that was $10 with the board. After building that one, I felt it was well worth the price of the board for the convenience and nice appearance of the finished keyer. Contact Embedded Research at embres@vivanet.com or check out their web page at http://www.vivanet.com/~embres to get their latest prices.

It's amazing what has been accomplished with a PIC microcontroller. I've got several Curtis keyer chips waiting to go in various rigs and I'm wondering now if a $10 8 pin DIP memory keyer wouldn't make more sense. These keyers are definitely going out with the club on Field Day. 72 es 73, Darrel Jones, WD6BOR

Embedded Research offers the following TiCKs in the Surface Mount (SOIC) pack-

age, with surface mount components:

•TiCK-1 Chip + datasheet ($5 postage paid within the CONUS)
•TiCK-1 Chip + manual, and Printed Circuit Board ($10 ppd within CONUS)
•TiCK-1 Chip + manual, Printed Circuit Board, and Parts ($16 ppd within CONUS)
•TiCK-2 Chip + datasheet ($10 postage paid within the CONUS)
•TiCK-2 Chip + manual, and Printed Circuit Board ($15 ppd within CONUS)
•TiCK-2 Chip + manual, Printed Circuit Board, and Parts ($21 ppd within CONUS)

The TiCK-X SOIC parts kit includes: Board mounted parts: 2 capacitors, 2 resistors, 2 transistors, and solder. Off-board parts include 1 piezo audio device, 1/8" mono jack, 1/8" stereo jack, & 1 N.O. momentary switch. Doubles of the cap, resistor, and transistor are included for your convenience.

TiCK KEYERS shipped outside the US are billed as follows:

•Orders shipped within the Continental US, postage paid.
•Orders shipped to Western Europe and Canada, add $4.
•Orders shipped to the Pacific Rim, add $5.
•Countries not served by Global Priority Mail, add $6

Payment and Sales Tax information All orders shipped within New York State must include 8% sales tax. All checks and money orders must be drawn in U.S. dollars. Send orders to:

Embedded Research
P.O. Box 92492
Rochester, NY 14692

St. Louis Radials

by Dave Gauding, NF0R
nf0r@slacc.com

[Reprinted with permission from the August 1997 issue of **The Peanut Whistle**, the monthly journal of the St. Louis QRP Society.]

St. Louis Radials are specialized accessories for the St. Louis Vertical. They can be used with other antennas requiring a ground radial system.

A Short History

The original "SLV" (1) is a 10 - 40M vertical supported by a ground mounted South Bend SD-20 collapsible fiberglass fishing pole. The antenna has a twinlead loading coil positioned at the base and is 20' high when fully extended. It is fed with balanced line and uses several folded twinlead radials as a ground plane. This vertical is compact, lightweight, and designed specifically for the portable QRP enthusiast.

Soon after the original SLV article was presented, N0TFI posted an elevated multiband loading coil modification (2) on the QRP-L list. Jess Gilpin's concept can be easily and enexpensively homebrewed. this was the first effort to take the initial antenna design a significant step further. Shortly thereafter, Vern Wright, W6MMA, introduced a manufactured elevated multiband loading coil (3) and an upgraded mounting base.

While the original design is a serviceable antenna both coil modifications improve the on-air performance. These new SLV developments are coax fed. Therefore, they are candidates for radial cut for specific bands as recommended by some manufacturers of vertical antennas.

W6MMA suggests homebrewed multi-band radial sets fabricated from rotor cable. An idea sheet that accompanies his loading coils became the impetus for developing the St. Louis Radials.

Rotor cable radials build quickly.

While acceptable in a fixed antenna installation the weight and bulk produced by three or five wire rotor cable may not be compatible with some portable activites including backpacking. The circumstances compound as more radials are added to the system to improve performance.

After browsing the wire catalogs it appeared that flat cable might serve as a lightweight alternative to rotor cable. Sixty plus feet remanined on the shelf after a failed miniature loop project. Excess inventory promped the decision.

Off and Running

St. Louis Radials or SLR's are a low cost homebrew project using off-the-shelf components. They are truly portable radials that may be built for one band or configured for many bands. Folded ribbons can provide a significantly smaller antenna footprint. All variations install and store quickly.

The original SLR covers 40M, 30M, 20M, 17M, 15M, 12M and 10M. It is fabricated from seven adjoining conductors of Scotchflex #3301 flat cable, a.ka. computer cable or ribbon cable. The 3M product features twenty-five #28 AWG stranded wire conductors. Any similar flat cable can be substituted. Wire size and spacing are not critical.

A typical SLR set consists of five ribbons containing a total of thirty-five radials in close proximity. The number chosen is a compromise between performance potential and practicality in the field. It is truly a question of how much time a portable operator has available for installing radials and later retrieving radials while on site. Builders should feel free to add or subtract at will through three ribbons are considered to be the minimum.

Design Conderations

Once the decision was made to use flat cable two significant problems had to be solved. Above all else it was necessary to insure electrical continuity with such fine stranded wire. In addition, solder joints had to survive repeated flexing during numerous antenna installations. The common alligator clip provided the answerws.

For convenience in the field SLR's continue to use speedy alligator clip terminations adopted for the original SLV's folded radials. The 2 1/4" Radio Shack 270-375 clip is recommended. It is a handy size, inexpensive and readily available. Even more importantly this model has an extended tube-style base to support a connecting wire or cable. After the seven adjoining conductors are rolled the ribbon will fit comfortably inside the clip.

As shown in Fig. 1, the original SLR's are only 3/8" wide and span 23 feet. The length was selected for two reasons. It allows unused wire in the folded 40M radial to do double duty on another band. and, one conductor can be dedicated to a continuous 30M radial. This avoids complicating electrical connections at the outboard end of the ribbon.

For simplicity, the original SLR's use the standard 234/F (MHz) formula for cutting conductors to approximately a quarter wave length. The dimensions in Fig. 1 are non-critical and favor the CW subbands.

Builders having access to an automatic hand held wire stripper for multiconductor flat cable are indeed fortunate. A well-equipped electronics lab or computer assembly/repair shop is a good place to start looking for a loaner. After this device is adjusted for the cable in use the stripping takes only seconds. A hand-held single wire stripper will perform the same task but as expected at a much slower pace.

Notching a ribbon's conductors in place allows originalSLR's to remain a complete unit yet isolates each band electrically. The 3/8" notch offers assurances that any broken wire strandsmigrating along the PVC jacket will not immediately short and affect performance. Nevertheless, operators will want to inspect multiband ribbons from time to time for this

eventuality.

Heat shrink tubing provides some additional support and a finished appearance for the alligator clip terminations. This feature may be omitted without penalizing performance. The joints can be finished with plastic electrical tape to achieve the same effect.

Origianl SLR's are terminated at the outboard end in the round plastic handle included with the Radio Shack alligator clip. The ribbon is epoxied in place which in turn protects the fragile solder joint of the folded 40M radial wire.

A barrel-type solderless ring terminal, a.k.a. crimp terminal is then epoxied into the opposite end of the handle. The completed assembly allows original SLR's to be tied off to a secondary support when used with an elevated vertical. The ring is also useful for pinning ribbons to the earth when the PVC jacket stiffens in very cold weather.

The base diameter of solderless connectors varies among manufacturers. Builders will need to experiment and may have to drill out or shim the plastic handle to accept certain sizes.

Placing a large number of alligator clips right at the ground point becomes complicated when using W6MMA's elevated mounting. Options include chaining the clips together, adding a simple extension to the ground point or replacing the alligator clips with compact solder lugs.

Materials for an Original SLR

23" of 3M #3301 Flat Cable (or equivalent)

1 Radio Shack 270-375 Alligator Clip (terminal screw discarded)

1 1/4" length of 3/16" dia. heat shrink tubing

1 Round Plastic Base Insulator form the Radio Shack Alligator Clip

1 Barrel-type Solderless Ring Terminal

Qucik Setting Epoxy Glue (Suitable for Plastic)

Homebrewing

a. Carefully peel seven adjoining conductors out of a 23' span of flat cable.

b. After practicing on scrap cable, strip 3/8" of insulation form each o fthe seven conductors at one end o fthe ribbon.

c. Fold the end into a U-shape and twist the conductors. Lightly tin the wire and trim neatly.

d. Slip the heatshrink tubing over the formed cable end and slide back out of the way.

e. With the thumb piece on the clip facing upwards slide the formed cable crease side up into the wire support until the insulation reaches the end of the tube.

f. Solder the tinned and twisted conductors to the alligator clip and allow the assembly to cool. The wrap-around wire support helps protect the insulation.

g. Now crimp the wire support using wide-jaw pliers and moderate pressure. Do not crush!

h. Slide the heatshrink tubing onto the alligator clip and shrink in place with a heat gun.

i. Lay the ribbon out on a hard work surface. Following Fig. 1, mark 3/8" notching points for each conductor on the ribbon. Measure from the tip of the alligator clip.

j. Jusing a sharp hobby knife carefully place the notch in each conductor. Remove the trimmed wire and discard.

k. At the outboard end of the radial measure in 3/8". Cut the five inside condutors to size. Leave the two outside conductors intact.

l. Strip 1/4" of insulation form the two outside conductors. Neatly cross these wires, gently twist and solder together. Bend the completed joint inwards so it rests protected in the valley formed when the seven conductors are rolled into a tube-shape.

m. Degrease the end of the ribbon. Lightly coat the folded ribbon inside and out with the epoxy. Slide into the plastic insulator for about two-thirds of its length.

n. Lightly coat the sides and end of the ring terminal and place in the opposite end of the insulator. Leave a slight insulating gap between the terminal and the ribbon. Add epoxy as needed to complete the assembly.

Ramblings

SLR's install immediately. Just give the rolled ribbon a light underhand toss while standing at the feedpoint. The heft provided by seven conductors and the PVC coating does all the work. The ribbons rarely tangle!

Single SLR's roll into a four or five inch diameter coil for storage. The process takes about one minute for a typical ribbon. With a little dexterity several ribbons may be overlapped and rolled at the same time. Stack the ribbons vertically in a round plastic kitchen container between card stock separators. This is a very compact system.

Like full size radials, SLR's can be bent to fit inot confined antenna sites. This is a better approach than leaving ribbons out of the system because of space considerations.

SLR's consistently handle 50 watts without difficulty. 100 watts output is assumed to be a realistic limit but has not been thoroughly tested.

SLR's can serve as quarter-wave counterpoises. For indoor stations run the ribbons along baseboards or under carpets. To provide a ground for a random wire antenna attach to the ground lug of the tuner.

About 35% of the available wire in an original SLR is unused. However, all of the conductors can be cut to the same length to leave the ribbon intact. Creating a dense groundplane with a great deal of strategically placed wire seems to have a positive effect on antenna performance.

The St. Louis QRP Society uses several radial configurations for Field Day and other portable operating events. One specialized set of SLR's contains twelve ribbons of six conductor flat cable in identical 16 1/2 foot spans. This particular system contains 1188' of wire and is very effective under a ground mounted 20 M Vertical.

SLR's constructged without a folded radial or normally positioned on the ground could omit the plastic handle and ring terminal. Trim the outboard end of the ribbon for the lowest operating frequency or any other frequency and the assembly is complete.

Additional space saving folded radials can be included in a ribbon by looping more conductors and re-configuring the band selection. Take precautions to avoid shorting out adjacent conductors and degrading performance.

Users of W6MMA's 10-80M coil may want to build a folded multi-band SLR that includes 80M. Supplemental folded twinlead radials or individual quarter wave wire radials cut fo rthat band are possible alternitives.

Two SLR's have been used successfully as a tuned doublet. Three ribbons have been joined to produce a tree hung vertical with drooping radials. A portable elevated mounting for the St. Louis Vertical which used original SLR's for the radiator and radials has also been tested. The results were encouragin and are worthy of further development.

SLR's are a straightforward project for adding a useful ground system to portable vertical antennas. No effort has been made to compare the performance of closely spaced wire ribbons to traditionally spaced radial wires in this application.

Wrapping It Up

St. Louis Radials are a non-technical, low cost design and easily homebrewed. While intended for the portable QRP operator they can be installed in permanent locations.

SLR's work for me and I'm confident they will work for you too. Recommendations for modifications, improvements and

related applications are officially encouraged.

References:

1. The original St. Louis Vertical article was published in the August 1996 issue of the St. Louis QRP Society's Peanut Whistle and reprinted in the September 1996 issue of NorCal's QRPp. The article and updates are currently posted on NorCal's web site at: (http://www.fix.net/~jparker/slvt.html)

2. N0TFI's coil modification is posted to his web site at: (http://www.concentric.net/~jessqrp)

3. W6MMA's modified coil and base mount products are posted at: (http://www.fix.net/~jparker/w6mma.html)

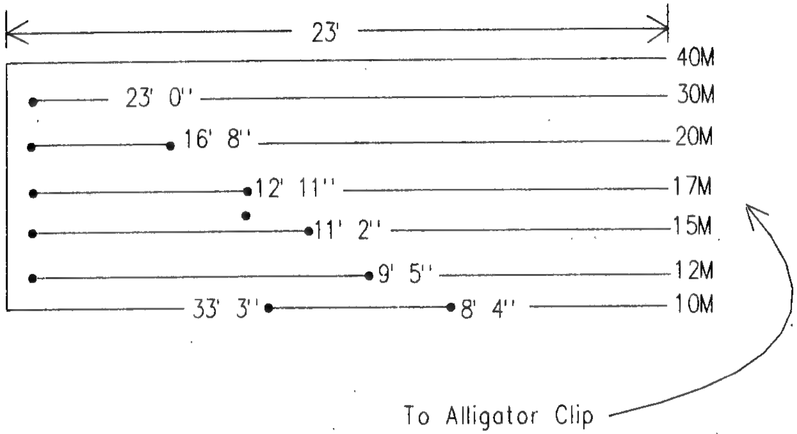


Fig. 1, St. Louis Radial (Not to Scale)

Get on 6M FM QRP The Cheap Way

by Jim Berger
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Monrovia, CA 91016

WA6CAS, John, and I are always looking for fun projects. At a yard sale there was a 49MHz pocket radio in a box. What the heck, for two dollars how can a guy go wrong? Buying this jewel was only the start of a fun QRP project. The first thing that I noted was that the 49MHz radio was FM and had PTT or Vox operation, and a nice headset with antenna. Now comes the fun part, I decided that 52.525 MHz is the place for this radio.

Removing the PC Board, I found to my surprise a very nice FM radio with a crystal filter in the receiver and tuned circuits in the transmitter. When I removed the transmit crystal, I found it was multiplied 3 times for the transmit frequency I.E. 16.610 MHz x 3 = 49.830MHz.

It was simple to move the transmitter to 52.525MHz. 52.525 divided by 3 equals a 17.50833 MHz.crystal for the transmitter.. Now for the receiver. I assumed a 10.7MHz If which is pretty standard. Then, 49.83MHz - 10.7MHz = 39.130MHz for the receiver crystal. To get to 52.525MHz I would need to do the math, 52.525 - 10.7 = 41.825. With this information I made the decision to order the crystals. I use M-H Crystals, a local house that does small orders. I gave them

the original crystals for a sample. In about 2 weeks the crystals arrived and in they went.

Using a field strength meter we adjusted the transmitter for maximum output, which is about 100 mW. The frequency adjustment was done with a counter (or a a receiver on the receive frequency).

I used an RF generator and tuned the receiver up and was surprised to find how sensitive the receiver was, about .75mVfor 12 Sinad, not bad for a 2 dollar radio.

I changed the extra earphone jack to an external antenna jack. We haven't worked a lot of DX yet, but it does have a range of 1/4 to 1/2 mile on the headphone whip.

This is a great project for swapmeets, antenna range measurements, field days, etc. Now if the sun would help us out and bring the cycle up maybe I could work a little real DX with my 2 dollar radio. Good luck and good hunting. If anyone needs help or information, feel free to write. My next goal is a cheap 6 meter beam. 72, Jim, NK6P

The Penultimate QRP Accessory

by J. Frank Brumbaugh, W4LJD
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Salinas, PR 00751

I use the word "penultimate" because, while no one can ever design the ultimate anything, this is my attempt to come close and provide a small, inexpensive and easy to construct accessory that every QRPer will find very handy to have.

What will it do you ask? A 1 1/2" round 100uA hermetically sealed meter (Fair Radio Sales, #25AFC, $7) with a linear 0-25 scale allows measurement of DC voltage to 15 Volts, DC current to 2.5 Amperes, and relative field strength from your antenna at the flick of a switch. These same three switch positions also allow access to crystal marker frequencies of 100, 25 and 10 kHz when power is supplied from a panel toggle switch. In addition, audio from the rig is fed to it and activates a 1 watt round speaker (All Electronics, #SK-175, $1.25). An 8-ohm speaker, it was designed for cellular phones and has an enormous magnet just slightly less in diameter than the cone. The speaker is front-firing and matches the meter (approximately) in size. Phones can be plugged into this unit and will mute the speaker. The overall schematic is illustrated in Figure 1. The wafer switch S1 is actually a 4-pole three position switch. There is an unused one pole three position switch section wasted now, but it is there for some one to add more goodies and possiblly rescue it from its penultimate position.

I did not specify resistances for the meter multiplier (Rm) nor shunt winding details (Rs) because it is highly likely that a junk box meter will be used and not the specific meter I used, and these will have to be calculated for the particular meter movement used.

The five TTL chips in the crystal marker generator can be constructed on perf board, or a general purpose pc board such as Radio Shack 275-150. I suggest using sockets for the chips because there seems to be some bad 74LS90 chips on the surplus market. If it is wired correctly and all chips are good, it will work perfectly. The microprocessor crystal can be zero-beat with WWV, or a receiver with digital readout or a frequency counter can be used to put it exactly on 10.000 MHz.

Of course, any even-megahertz crystal can be used instead of what I used, but the 74LS90 following the oscillator chip

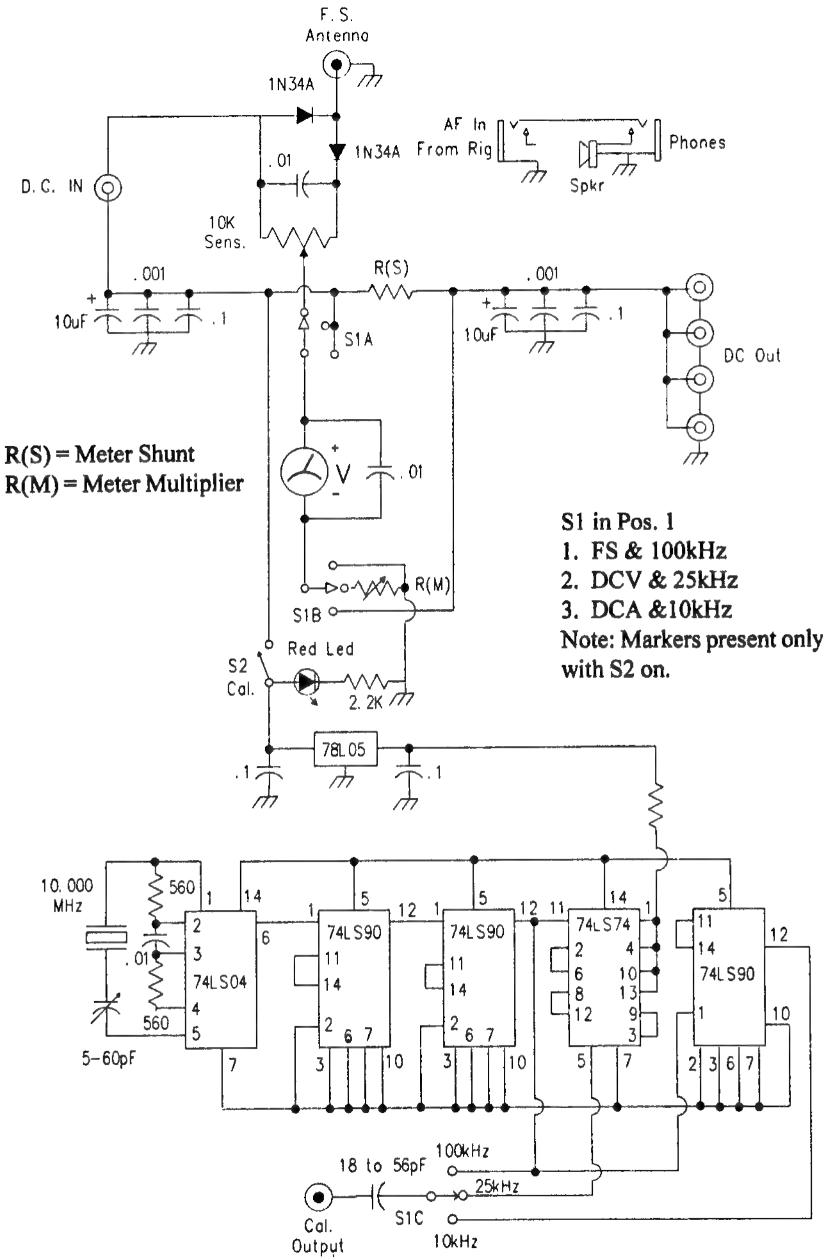


Fig. 1 Schematic of Penultimate QRP Accessory

will have to be wired to divided so it's output will be 1.000000 MHz when the crystal is trimmed to its marked frequency.

The 74LS90 can be configured to divide by any whole number between 4 and 10. A 74LS74 can be used instead to divide by 2 or 4. But by using a common 10MHz crystal, the division ratio is so high that drift from aging or temperature in the field will not move even the 100 kHz output more than a single Hertz.

You will notice some very heavy bypassing both where the DC enters and where it leaves the unit. While this may not always be necessary, I have saved myself a lot of headaches by bypassing this way every place a DC operating voltage leaves or enters an enclosure. It is cheap insurance.

I used RCA panel mount jacks for all DC connections, and four are wired in parallel on the output to accomodate other powered accessories besides the rig.

The output for the calibrator is a binding post on the panel. I used a panel-mounted elbow BNC female jack on the rear deck which matched my home brew whip antenna for field strength measurement.

The LED is illuminated only when the calibrator is turned on, as a warning to turn it off when finished checking calibration of the rig.

How big is it? Mine is contructed in a Ten-Tec TG-34, whcih is approximately 3"H x 4"W x 4"D. The 3" x 4" panel was needed for the meter, speaker, rotary funtion switch, calibrator toggle switch, LED and phone jack. It could have been built in a much smaller enclosure but this is what I had handy, and it matches the rest of the home-brew gear in my station.

I have noticed in all of my crystal calibrators that an untunable low amplitude high audio frequency can be heard in the receiver when the calibrator is turned on. I do not know its source but the heavy bypassing does deep the amplitude very low. Hopefully someone who builds this unit will find a use for the unused 1P3Pos switch section. There is plenty of "air" in this enclosure that isn't being utilized. 72, Frank

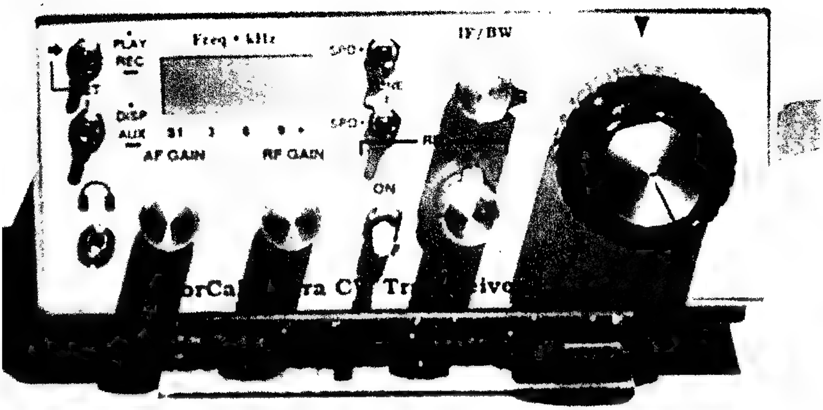
Homebrewing the Sierra

by Nick Hulbert
E-mail: tnickh@aol.com

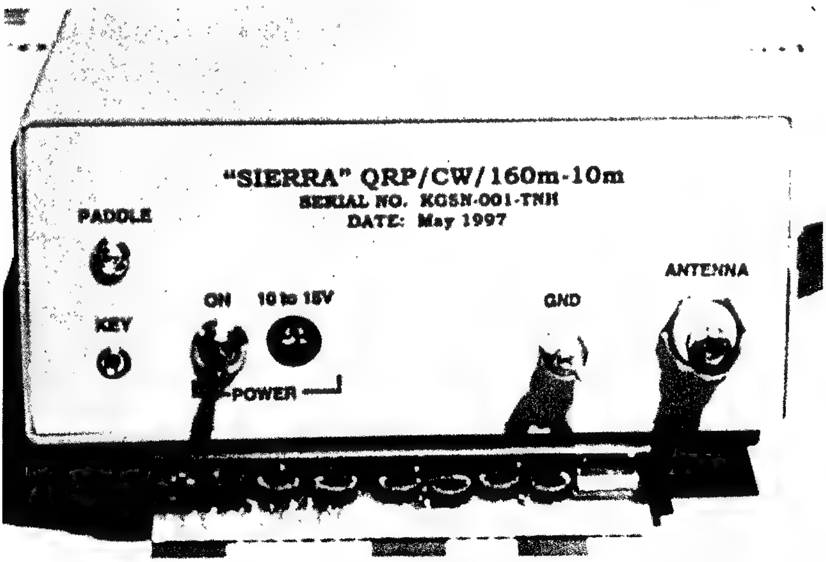
I was first introduced to the Sierra in early 1996 when I heard about it during a QRP contact on 40m. We were chatting about QRP rigs and the other station mentioned the Sierra from the NorCal QRP club. What really caught my attention was his mention that it was a multi-band rig and used "plug-in" modules. My interest peaked even higher when he mentioned it was in the ARRL Handbook. But as many of you may have experienced, further pursuit was OBE (Overcome By Events) with higher priorities like work, home, and church.

My next encounter with the Sierra was more dramatic when a friend (Paul, W0RW) purchased the Wilderness kit version and brought it to work. During lunch we put the Sierra on the company 3 element beam and WOW!! I knew I had to have one ! The next obstacle was the ham budget for the Wilderness kit. Remember those other priorities I mentioned, well I have a daughter (Shannon, KA0ZHP) in college and that's hard on the ham budget. So I made a quick inventory of the Sierra parts list and the "Junk Box" and decided to build the version from the 1996 ARRL Handbook.

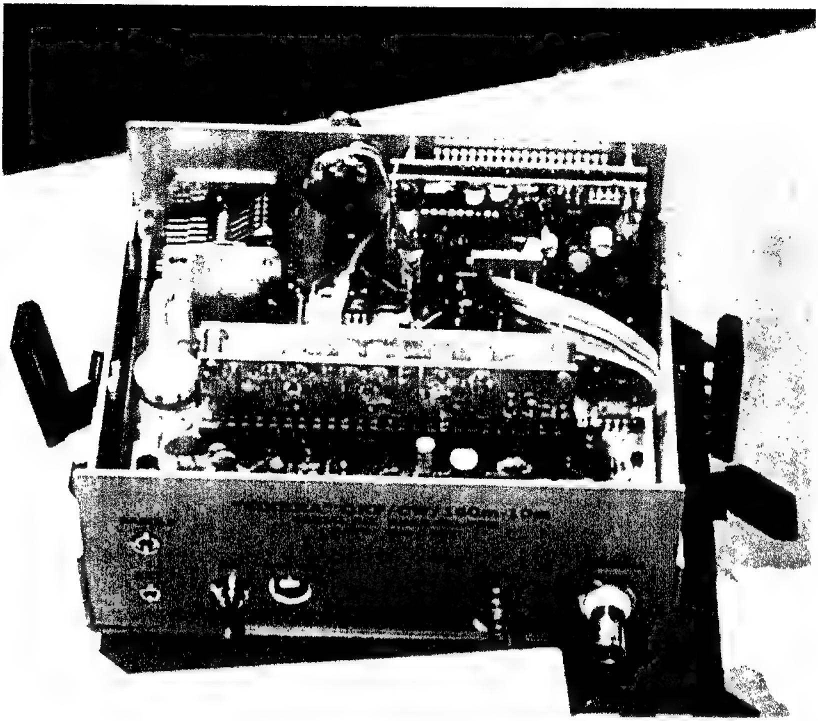
I started collecting parts for the Sierra and received the ARRL Template package back in September 1996 including a few e-mails with Wayne (N6KR) who was very helpful and encouraging. I pretty



Front View of the Sierra Homebrewed by Nick Hurburt



Back View of Nick's Sierra



Interior View of the Sierra

Nick Hurburt, KG5N and his "Creation"

much followed Wayne's template package as he provided it to the ARRL. The dimensions and mechanical drawings were very precise and allowed fabrication of the cabinet without too much difficulty (less the rectangular hole for the KC-2). The cabinet design is really quite nice and could be used for many different projects. It's essentially a same size front and back aluminum panel with duplicate top and bottom covers. I painted the cabinet using "on sale" spray paint from WAL-MART.

The PC boards were fabricated using two presensitized 6"x 6" double-sided G-10 boards available from the local electronics store. One for the main Sierra board and one for the band module boards which yielded 5 band modules. I used overhead projector transparencies and a copy machine to transfer the top and bottom etch patterns from Wayne's template package to the transparencies which served as positives for exposure. I did have to use two doubled-up transparencies per side to be sure the positive was opaque enough to keep light out of unwanted areas. It worked great!! I nickel plated the boards with a plating solution mix available from Semiconductor Specialists in Phoenix, AZ ($4.95). Total cost of material and chemicals for the main board and 5 module boards was about $30.00. Keep in mind these boards are not through hole plated or silk screened, just double sided.

Now for the parts collecting. After an inventory of my personal stash of junk box parts I estimated about 75% of the components I already had on hand. The items I still needed were the tuning and trimmer caps in the VFO circuit and modules, most of the toroids, 26 gauge wire, some NPO's and Silver Mica caps, polystyrene caps, and the panel mount controls and board mounted stereo connectors, knobs, varactor diodes and one IC, band module connector, xtals, and hardware odds and ends. A few mail orders later (Mouser, Dan's, Digi-Key) and a couple swapfests I had the complete list of parts on the bench. I knew I wanted to use the KC-2 but waited to order it until I had convinced myself that the rig would not end up as another uncompleted project in a box. Yes, I do have a few of those!! Total cost including the KC-2 came to $175 for this version of the Sierra and 5 band modules.

Assembly of the main board went smoothly using the ARRL template component layout guide and schematics. I started with the resistors and lower profile parts first then worked my way up to the larger components working one functional section at a time. The band module connector (J5) and the stereo headphone and key jacks were the only components I had to consider because of not having plated through holes in the board. The J5 connector has several "through-hole" locations which move signals from one side of the board to the other. But you can't use regular wire because the connector must fit flush with the board. Remember you need mechanical strength here because you'll be removing and replacing band modules. So, I drilled the through hole locations maybe one drill size larger to accommodate some thin nickel plated flat ribbon wire (not computer ribbon wire) which could be passed through the hole and could lay flat on the pad (each side) for soldering. Then using a much smaller drill bit's shank end I was able to form the flat ribbon wire around the inside of the hole making room for the J5 connector pin. Real care was taken with the J5 connector location on the board to be sure of good connections passing top to bottom. Probably the most difficult aspect of making your own Sierra board is J5. All other board through hole connections can be easily taken care of by simply being sure you solder both leads of the resistors, caps, and some transistors on both sides of the board. Once committed to soldering the J5 connector on the board it won't be easy to remove, but possible if necessary. The band modules don't require

any ribbon wire as many of the component leads performed the through hole function. I also allowed for modifications collected from the QRP-L and notes from Wayne (N6KR) like the ferrite bead on the base of the 2N2222A RF driver, the 4.7uH inductor to shift to upper sideband, and the back panel ground connection which was deleted in the Wilderness version. On the band modules I used the "Optimized Sierra Output-Filter Values" for L5 & L6 published on the QRP-L by Dave (W6EMD). Dave uses some different toroid core types on some bands other than what is called out in the ARRL template package and some changes in the capacitor values for C47, C48 and C49.

I completed the 40M module first and fired up the board to immediately hear cw signals. Once I tuned the input bandpass filter the signals were quite loud and the AGC was within range. I aligned the VFO next which required some tweaking of the L7 toroid inductor. The PMO aligned quickly and the first keydown test actually put out some RF. After alignment and checking the power out on a scope I was making about 2.4 watts on 40M. A spectrum analyzer check showed the 2nd harmonic to be down about -37dbc so I knew the output low pass filter was working OK. The 30M module was next and it performed in a similar manner. I also built the 80M, 20M, and 15M modules and I noticed as you go higher in frequency the tuning of the modules is notably more sensitive to alignment. I've decided now that I want to build the 17M and 12M modules so I'll have to etch two more boards since I could only fit five on one 6" x 6" presensitized board. One note: Some of the PMO crystals used on each module are not easily available. I was fortunate to find some of them at a local surplus store and from my junk box collection. But, you can buy them from International Crystal Manufacturing Co. The ARRL template package specifies the crystal part numbers and frequency required for each band.

Now if you really want to put a rig to the test and challenge its performance then put it on 20M CW during Field Day. That's what I did with my completed Sierra in June at Field Day 1997. My entire Field Day station consisted of the Sierra, a small Gel-Cell battery, a solar panel, and my portable 40ft mast and dipoles. I went to the mountains of Colorado, Mueller State Park (10,000Ft), and sent up camp and the station. The Sierra performed flawlessly. I made a few field tweeks of the alignment as I could faintly hear the opposite sideband coming through on strong signals(easy adjustment fix), and I adjusted the receive v.s. transmit frequency. One of the nicer features of the ARRL NorCal Sierra version is the ability to monitor your own transmit signal as the sidetone. Tune in a signal to match your sidetone and you're on frequency. That is a very nice feature for working Field Day stations packed so close in frequency. Especially if you're running QRP.

I have certainly enjoyed building and operating the NorCal Sierra. I've also appreciated the encouragement from Wayne (N6KR) via e-mail and a couple local hams in Colorado Springs, Paul (W0RW) and Rick (K0SU) who kept me motivated by constantly telling me on 2-meters how great their Wilderness Sierras were doing. I was also very encouraged by Mike WC5Z in Lubbock, Tx who kept asking me during our 80M sked each week how the Sierra was coming and........Is it done yet?

As a NorCal member I've really felt like a part of the group by reading the NorCal web page even though I have not been able to attend a meeting. The coverage of the meetings, pictures of the rigs, and people have really allowed me to enjoy the spirit of the club. I asked Jerry WA6OWR who maintains the NorCal Web site if he would be willing to include some photos of my NorCal Sierra and this write-

up so I could share my experience with the club. He went a step further and offered to put it together and actually take it to the next club meeting . Jerry took the pictures to the July NorCal meeting and setup a display. Then Doug KI6DS offered to include the pictures in the QRPp. I'd like to add my sincere thanks to all of you, the NorCal membership, for keeping the spirit of Ham Radio alive and well. Hope to hear you on the bands.

Now what do I build next? 72, Nick KG5N

Iambic Keying --- What's It All About

by Chuck Adams, K5FO
adams@sgi.com

In order to run, we first must learn to walk. First law of education I'm sure. Let's do some statistics. We just love to play with numbers. It is something that is measureable and you can't argue with the numbers most of the time. You can play with them, but you can't argue. To the best of knowledge I truly believe this is the first time that anyone has done this analysis. It does make thinks much clearer on the evolution of devices used for sending Morse Code.

Let's first start with the straight key and just how you send with a simple device. As with most things in life (I do tend to get philosophical but then again I'm the writer) the simpler things usually require more operations and more time to complete. Take as a simple example of digging a ditch about 50 meters long, 1 meter wide and 1/2 meter deep. That's a big ditch. Let's make the task easy and say it is fairly loose soil and has no large obstructions like bolders, etc. No worry about underground power lines, pipelines, other things that bother people and cost a lot of money when you run into them and cause damage.

To construct a ditch you remove all the soil that is in it. Think about removing all the soil within this volume. With a simple shovel you have a pretty awesome task. It will take literally thousands of movements of shoveling and tossing the dirt out of the ditch.

Now attack the same task with a ditch digger or backhoe. With machinery the task becomes almost trivial. There is of course the budget constraints and that is also important.

Now back to the task of sending Morse with a straight key. You sit upright with your arm from the elbow to the wrist on the tabletop and do all the things that you need to do to send perfect code. Let's look at the number of times you have to press the key and make contact for each of the letters. What I'll do is put them in order of number of motions required. The timing, i.e. the length of time you hold the contact closed determines the final pattern and the sounds that come out. You should be able to do this error-free, even though you long ago gave up the straight key. It's like riding a bicycle, you never forget. You may be a little rusty but you can still do it.

Here are the number of strokes it takes to send each letter using a straight key, a.k.a. hand key.

Number --- Letters that can be sent
One Stroke --- E and T
Two Strokes --- A, I, N, and M
Three Strokes --- K, O, S, U, W, R, D, and G
Four Strokes --- B, C, F, H, J, L, P, Q, V, X, Y, and Z
Five Strokes ---- 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0

So if I asked you to send the entire alphabet and all the numerals you would have to work the key a total of 2 + 8 + 24

+ 48 + 50 which is 132 key closures. No wonder you get tired after sending a long session with a straight key and you aren't in shape.

Now let's graduate you to the old 'bug'. Historically the bug was invented before we had a lot of digital designers around who weren't making the big bucks in computers. Go back through the literature and look at the cost of the bug in 1940. Just remember that the minimum wage at the time was under $1 an hour. The bug was invented to speed up sending. Guys could copy faster than could be sent without papertape generated Morse and other mechanical means. Can you imagine the surprise of the first unsuspecting guy to be on the receiving end of the first transmission? So here is the count, as I remember it. Please be forgiving for any errors in this part. OK?

One Stroke --- E, I, S, H, 5, T
Two Strokes --- A, B, D, M, N, 6, U, V, 4, 6,
Three Strokes --- F, G, K, L, O, R, W, X, Z, 3, 7,
Four Strokes --- C, J, P, Q, Y, 2, 8
Five Strokes --- 9, 0

Again, totaling up the number of strokes we get 6 + 20 + 33 + 28 + 10 giving us the winning number of 87 motions. This is quite a savings over 132 strokes required for the straight key. Timing-wise it gave the operator considerable more accurate timing on the dits. There is still a limit of human capabilities to send by hand each long element.

Then came along the first electronic keyer. Historically someone with more time and energy can research this one. My first keyer was the Hallicrafters TO keyer, some time ago for you young critters in the audience. No memory, just a plain two tube keyer.

Now let's again go through our counting exercise but this time using only a single lever paddle. Some of the better CW ops that I know still only use a single lever paddle. I can see that it closely approximates a bug in operation and it would be a much simpler transition to the new technology with a rapid learning curve. Here is the count that I get.

One Stroke --- E, H, I, M, O, S, T, 0, and 5
Two Strokes --- A, B, D, G, J, N, U, V, W, Z, 1, 2, 3, 4, 6, 7, 8 and 9
Three Strokes --- F, K, L, P, Q, R, X, Y

Wow!! That saved a lot. Totaling up the damages we get 9 + 36 + 24 for a total of 69 which again is a reduction from the previous two methods that involved 132 and 87 strokes for their respective totals.

Then came the dual Iambic paddles and more sophisticated keyers. Often referred to as 'squeeze' keying since the physical motion of the fingers is like squeezing the two paddles together in sending a some of the characters. It matters not a hill of beans whether you are using mode A or mode B for the keyer. I'll come back to that topic after we get the numbers.

One Stroke --- E, H, I, M, O, S, T, 0, and 5
Two Strokes --- A, B, D, F, G, J, K, L, N, Q, R, U, V, W, Y, Z, 1, 2, 3, 4, 6, 7, 8 and 9
Three Strokes --- P and X

Now we have 9 + 48 + 6 for a total of 63 strokes with again a savings in strokes, but only about a 10 percent gain. It is enough, and we'll take all the help we can get. Of course, for the highest of the highest speeds you gotta make the next logical step to a keyboard and 'voila!' you can get any character in one stroke. Just had to throw that into this article to make it somewhat complete.

So look at the totals again 132, 87, 69, and 63 for each of the methods of sending Morse. Now you need to sit down with an Iambic paddle and a keyer that does the mode A or mode B and practice sending. Here are my recommendations.

o Set the keyer speed to 13 wpm or so.
o Set the spacing as small as possible on

the dit and dah side.

o Adjust the tension as light as you can stand it and then lighten it some more.

o Keep the fingers as close to the paddle as possible. Don't let them get too far away, this is important.

o Do not 'slap' the paddle, just a gentle touch should do.

o Practice getting the feel of the paddle. Try sending just the dit or the dah side with variable number of each. Try not to count as you send E,I,S,H,5,T,M,O, zero etc. Try alternating combinations of dits and dahs.

o Get a blank piece of paper and write down the alphabet, either random or alphabetical order and the numbers.

o Send each letter 10 times, very carefully making sure it comes out correctly. Keep doing this until you can send each letter 10 times without a single error. Figure out the minimum number of movements to send each letter. Do they agree with the numbers above?

o Then get a book, newspaper, or something that you enjoy and start sending the text. Practice until you can send text with proper spaceing.

I am afraid that I am the type of individual that is somewhat of a purist when it comes to Morse. I want to hear spacing ratios of 1:1:3:5:7 for the various parts. People who claim that the 'fist' or the 'personality' of bug sent code is music to their ears haven't tried it at high speeds. It slows things down IMHO. Been there and done that.

It is my hope that this article will help others enjoy and understand the mechanism of using Morse and relieve some of the hardships that doing it the hard way brings. See you on 40M this winter and I'll go at your speed. I don't enjoy oneway conversations. dit dit Chuck Adams K5FO

The 38 Special the Arizona Way:

Build the 38S with all of the mods in one article.

by Gary Surrency, AB7MY
gsurrency@juno.com

Ok, I've been asked for this by several people. So here it is. Hopefully this will motivate anyone who is still holding out building their 38S, doing mods, or those who have just bought one or will in the future. I've included all the mods I've done to mine, and I consistently get nice signal reports. Some hints are included to help you along the way to finishing your kit. Anyone who comes up with more info or suggestions is welcome to add or amend to what I've done. Enjoy!

These mods have been refined over a period of a few months, and have made my 38S darn fun to operate. The mods require very little trace cutting, and minimal parts added to the top or bottom of the PCB. The result looks really nice, and it is hard to detect the mods unless you look real closely.

Rule # 1. Use sockets. It's no fun desoldering an IC that was installed backwards, or one that has expired. I like the gold plated machine tooled type sockets. Circuit Specialists (1 800 528 1417) nearby in Mesa, AZ has them for 30 cents for an 8 pin socket to 75 cents for a 20 pin socket. Use whatever you prefer or can get locally.

Make sure to use plenty of light when building the kit, and use a proper PCB holder. Doug Hendricks showed at the Tuthill hamfest a simple holder that Chuck Adams had made. It's a 4 inch square piece of wood with two 2 x 4 inch pieces 1 inch thick glued, nailed, or stapled to the outside edges of the 4 inch sq. piece. This makes a "U" shaped piece upon which you

attach two wooden clothespins. The clothespins will hold a small PCB just right for soldering, and the whole thing is inexpensive and readily made. It also makes a great "third hand" for soldering connectors, etc. Thanks to John Nystedt, KJ7YN for passing these out to the members at the last ScQRPions meeting . Gracias!

If you are near-sighted, don't wear your glasses or contact lenses while building. You'll have much less eye strain when working up close if you don't wear corrective lenses. If you are not near-sighted or are far-sighted instead, use a magnifier lens. 63/37% tin/lead alloy solder is best, or the 62/36/2% tin/lead/silver solder from Radio Shack is real good too. These alloys have excellent wetting ability and a low melting point to reduce PCB and component damage. The supplied PCB from Norcal is of highest quality, and will survive all but the most ham-fisted builders!

Use a small 1/8" to 3/32" iron plated tip. I use a Solomon temperature controlled iron with digital temperature display. It was about $86 from Circuit Specialists.

Watch out when bending the leads of the monolithic caps to fit the PCB holes. They are very fragile, and will not survive stress from forcing them into place. When the heat from the soldering iron hits them, they can develop an open circuit and you can't tell by looking at them. Troubleshooting this is very difficult and time-consuming, so take care with their leads. Ok, enough of this. Onward to the mods!

RECEIVER MODS:

T1 has only 18 turns, instead of the 19 turns specified in the manual. You should have two peaks of trimmer TC1. There is a small "dot" on the type of cap my kits were furnished with, and this can be used to determine the position of the cap. I compress or expand the toroid windings until I get the "dot" to peak midway between the flattened side of the cap and the opposite side. This gives the most range of capacitance for tuning, and insures T1 isn't too big or too small in inductance.

C4 is changed from .01uf to 10pf to better match the input impedance of U1, the NE602. This also maintains the loaded Q of T1 higher to allow better rejection of SW stations just outside of the 30m band. Some very strong SW stations may still bleed into the rig under exceptional propagation. A better input filter would be nice here during those times, but it's pretty good as is. I tried smaller values, such as 5 pf or 8 pf, but there was an unacceptable loss of sensitivity. I recommend use of an antenna tuner or carefully trimmed resonant antenna. I use a sloper dipole matched with a LDG QRP autotuner.

It is essential to put a bypass cap from D6's cathode to ground. The reason is the AC ground for this point is way across the PCB at C30, near the key input at wire pad # 9! Not good for stability, as D6 is supposed to ground C21 during transmit to accomplish the T/R offset. If you remove all the solder from the hole where D6's cathode goes, a small .1 or .01 uf monolithic axial cap will fit perfectly from the same hole as D6's cathode to a nearby PCB ground hole just above the silk-screened "1996" near the copyright symbol. You may need to flatten one or both leads to get them to share the same hole. Better transmitter stability and reduced chirping and spurious output will be the net result. TC2 also behaves better.

You can use one of the .1 uf caps that would have gone at C39 or C41, near the LM7808 8 V regulator. This is because these are replaced with 22uf and 10uf tantalum dipped caps. I found this helped reduce the infamous "thump" this rig has had for many builders. The .1uf caps are just too small for proper regulator decoupling. You can get these caps from your local parts supplier or check an old PC add-on card or discarded TV for some suitable caps. C39 needs at least a 16 volt rating, but C41 can be 10 volts if that is what you find. Both caps could be 22 uf if that is

what you have - I didn't have enough 22 uf caps for both kits. Use tantalums though, as they have *much* less series inductance, and are best for power lead decoupling.

If you have a scope, watch the DC level of the 12v in and 8v out of VR1. Any large pulses during keying is reason for alarm. So if your 7808 is crummy, try another one or examine the caps just mentioned above. Pulses from the 8v regulator have been reported by Paul Harden, NA5N and others (including me!), so watch out for this potential problem. Keying noise on the 8v supply is hard to clean up in the other areas of the circuit, so it is best to nip it at the source.

Similarly, the 8v bus as it is applied to U5 and TR1 is rather poorly decoupled. If you look at the 8v trace as it extends from the output of the 7808, there is a long PCB trace with no additional decoupling on it. I placed a 4.7uf tantalum on the tops of R25 and R26 on the ends nearest TC2. The positive lead goes to R25, or just below the unused hole next to the "TC2" silk screen. Additional stability and reduction of "thumping" results from decoupling TR1 and U5's voltage source.

If your tuning range at the high frequency end is too low, check the voltage of the 8V supply. If it is much below 8.00 volts, try another one. Some are off by a tenth of a volt or so, and will limit your tuning range. The 1N4004 diode used at D3 is also a critical factor in tuning range. This seems to be more of a factor at the low frequency end of the range, when the diode's inherent capacitance is at work. Try several before you solder it in, as there was a wide variation in tuning range when I experimented with a selection of 1N4004's. It might save you from using a different RFC for L1, or winding some wire around it to modify your tuning range.

On the bottom of the PCB, stretch a .1uf axial monolithic cap across from pin 8 to pin 4. I found this necessary on my 38S to prevent an audio oscillation that was occurring during keying from "ringing" of the 8V source to the NE5532. It sounded just like the sidetone! U5 has such high gain, it will "hear" and amplify anything coming in on its supply line. More audio noise was silenced. Ron, KA1KCU also noticed this on his rig.

As long as I'm on the subject of U5, let's talk about the audio output level. I changed R24 from 47 ohms to 4.7 ohms. This increases the output level quite a bit. The 4.7 ohm resistor was salvaged from an old computer power supply. You could use a jumper here, but the resistor fits and looks better! I used a R/S insulated stereo 3.5mm headphone jack. Use a hole large enough to pass the shoulder of the jack through the back chassis panel. A fiber washer finished with a metal one keeps the knurled nut of the jack from shorting out against the aluminum. I have used fiber washers salvaged from old binding post hardware if you are willing to enlarged the hole and sand or file the fiber washer smooth.

With both channels of the headphones in series, the audio level is adequate. I have tried several headphones, from Sony MDR-25 to R/S Nova 34 units, all with good results. The 25-35 ohm per channel impedance in series seems to work well with the drive ability of the NE5532. Walkman type amplified speakers will also provide fair audio levels if you want to let others listen, but the headphones are the way to go. Strong signals require the use of the RF gain to lower the volume.

Note: Some NE5532's are better than others! Try several if you have them. I like Signetics manufactured chips better than the JRC brand supplied with the kit. It just seems to have better Power Supply Rejection Ratio (PSSR) (less thumping) A TL082 J-FET input dual op-amp was even quieter, but it tends to overload and distort somewhat on the strongest signals. Probably it lacks sufficient output current capacity. My Signetics NE5532 was

scrounged from an old computer monitor.

While on the subject of thumping, I noticed an extreme tendency for PCB contamination to increase the thumping. Some of the T/R traces pass very near the high-gain audio circuitry, and any crud on the PCB conducts pulses into the audio chain. Clean the bottom *and* top of the board thoroughly in this area, as well as the rest of the board. A little bit of leakage here is impossible to silence, so clean it well with denatured alcohol and/or Formula 409 or equivalent and rinse it with water and dry thoroughly. A finger placed across this area will dramatically increase the T/R thumping.

C15 is reduced from 25uf to 1uf to roll off the low frequency response and reduce the coupling of low frequency noise, pulses, thumps, etc. I used a 1uf tantalum here. When the CD4066 switches off and on, it charges and discharges this cap. So the smaller it can be made, the quieter will be the thumping.

For the following steps and the PIN diode mod, you *must* install the TiCK keyer mod to free up the inverters from the sidetone circuit.

If your 38S is still making too much popping during keying, there is a final "thump" cure. It incorporates a FET switch to mute the audio line between U2 and U5. If you have a rig that uses FET muting, try its circuit here. Cut the trace from U2 pin 11 to C14, and solder a 2N3819 R/S FET across the cut, with the flat side of the FET toward the PCB and near U2's pins 12-14. The outer leads solder to the PCB just cut. If you use a different FET, just be sure to check the lead identification before soldering it in. An MPF102 would work just as well, but note that its pinout is different.

Next, solder a 1N4148 or 1N914 diode with anode to FET center lead (gate), cathode to U4 pin 5. Also solder a 1M 1/4 or 1/8 watt resistor across the diode. Solder a .1 mono cap from FET center lead (gate) to ground via hole adjacent to U2, pin 9. Use very short leads here. The FET, diode, and resistor are all mounted with minimum lead lengths tightly against the PCB. All of the components except the FET are installed in-line with each other when viewed from the bottom of the PCB. These steps using the FET got rid of all but a tiny thump that must be coming into the audio chain from some other source than the CD4066 chip.

Since I use a keyboard with its own sidetone, I didn't need a sidetone for the straight key jack wired to pads 9 (keying) and 10 (ground). The TiCK provides a sidetone when using paddles, and I found a 1 meg resistor for R17 gave me a soft sidetone volume that was just right. The programming tones from the TiCK are easily heard. Don't forget to cut the trace near U4 pins 4&5 when you do the TiCK mod. This isolates the inverter output of the 74HC240 from the TiCK's sidetone output. I like to use a small jeweler's screwdriver as a chisel to cut traces. Make a shallow cut from both sides, no wider than the width of the trace to be cut. This works better for me than an Exacto knife or similar tool.

Note that the TiCK keyer can be used in straight key (SK) mode, so only one jack could be used for both paddles and straight key or keyboard, and this would allow a sidetone for either type of keyer. If you do this, note that *either* the dot *or* dash paddle will key the rig in SK mode, so you will have to use a stereo plug with only the tip or ring wired to the SK or keyer's output, with the sleeve wired to ground. Otherwise the rig will key continuously when a mono plug is inserted into the stereo paddle jack. Alternatively, you could just put the plug half-way in the jack.

TRANSMITTER MODS:

To greatly reduce transmitter spurious output and improve spectral purity, replace *both* C25 and C26 with 330 pf disc or silver mica caps. The output of my rig was greatly improved by these two

mods, and TC2 becomes a lot less touchy to tune. L2 is at 19 turns, spacing adjusted so that TC2 in its mid-range when cleanest output is attained.

I also found that it seems to be best to adjust TC2 for the lowest frequency possible when at the extreme low frequency end of the tuning range. Some frequency pulling is apparent, and the chirp / drift at the low end is lessened when aligned this way on mine. You may find the "sweet spot" of adjustment is right on the verge of instability, so back off TC2 slightly for a stable output. Watching the reflected power on a QRP wattmeter when using a resonant antenna is a great way to find the best setting of TC2.

I cannot stress enough how important it is to have *two* peaks of TC2. The rig will not be stable unless this is true, and you may blow the PA transistor or the 74HC240 before you realize it. Check the turns of L2, and be sure to add or remove turns until there are two peaks of TC2. Trust me on this one!

Watch out for VHF parasitics when tuning TC2, and monitor Q2 to be sure it doesn't get fried while diddling with the trimmer. The DC supply current should be limited to 1 or 2 amps if possible, otherwise use a 1 or 2 amp fuse in the power lead. Q2 *must* be well heatsinked to save it from leaking it's smoke during these adjustments. Although when it is properly aligned, there isn't much heat produced.

Current draw is 27 ma during receive, and 800 to 950 ma on transmit depending on output level. I never lost my original IRF510 from R/S, but I have a spare just in case. Keydown for several minutes at 8-9 watts hardly heats the chassis rear panel. But you'll want to back if off to 5 watts or less to be "legal" QRP, plus this saves batteries when operating in the field. Adjusting L3 and/or L4 will achieve this.

It may be possible to further reduce the value of C25, lowering the drive into the 74HC240 and reducing loading of TR1 and the resulting current draw and frequency pulling at the lower frequency settings. I suspect there is a threshold value for C25, below which drive and stability is reduced, and above which the output spectrum suffers. Some additional experimentation here might be valuable.

Onward to the 5 watt mod. I kept the ferrite bead on R104, the 10 ohm resistor in series with Q2's gate. R101 and C101 are not used. C101 is replaced with a wire jumper. This method of driving Q2 results in good output, no current drain from bias on Q2 during receive, and great transmit efficiency.

If you forget to cut trace #1 marked in the manual when adding the IRF510 PA mod, you *will* blow U4, and possibly some other devices. When adding the 5 watt mod, the PIN diode isolation needs to be improved to reduce overloading U1's input. The 1N4007 diodes will also run cooler, and a small amount of RF is saved from dissipating heat in the 1K RF gain pot. Here is an excerpt from Mike Gipe's posting on this mod:

From Mike Gipe

This modification puts a reverse bias of 8 volts on the PIN diodes when in transmit mode, improving the switch isolation.

1. Make sure that you have removed D8, R15, R16, and C31. Also make sure that you have cut the trace between U4 pin 3 and R17. This is part of the TiCK keyer mod.
2. Now, put a wire jumper where D8 used to be. You did this anyway to keep U4 from floating.
3. There is a trace on the PC board, solder side, which connects R1, R2, and R14 to 8 volts. Cut it between R2 and R14. This leaves R14 connected to 8 volts, and R1 and R2 connected together but nowhere else. (I cut the trace right *after* it goes past R14. This makes the jumper wire as short as it can be - AB7MY)
4. Take a short piece of insulated wire (30 ga. wirewrap wire works well) and connect

the R1/R2 node to U4 pin 5. The empty hole where R16 used to be is a good place to connect to U4 pin 5. Route this wire along the solder side of the board near the path taken by the trace that you cut.

5. Check your work, then smile. You're done.

Mike K1MG

Thanks Mike! Note the PA mod in the manual is *not* the best one, and Mike's mod will insure the PA is not sensitive to power supply voltages above 12v. The PA is safely biased "off" when in receive, and the efficiency is very, very good. It's a marvelous circuit!

For the output filter, I had best results with the following values: C505 (on the schematic, the board is marked C501) is 560pf. C25 is 1000 pf, C26 is 560 pf. All caps are silver mica (used by me) or polystyrene for best efficiency. I used 11 turns for L3 and 12 turns for L4. By compressing or expanding the turns on these two toroids, I can get between 3 watts and almost 9 watts output. L4's windings are half-compressed at the top of the core, and L3's turns are spread evenly around the entire core. Experiment and arrive at the output level and spectral purity that is right for you and your rig. The second 38S I built needed 10 turns for L3, so there may be some variation in inductance required. Buy several 560 pf and 1000 pf S/M caps and use the one that produces the cleanest and greatest output. There was quite a difference between the ones I tried. Tack solder them in, or simply bend the leads at angles to hold them in place temporarily. I call this technique "blueprinting" of my kits.

CHASSIS IDEAS:

I mounted my 38S PCB right against the back of a nice aluminum cabinet from Circuit Specialists (catalog no. LA-4, $5.30). There is nearly 1/2 inch of clearance on the sides of the PCB to the case, and 3/4" between the front panel and the edge of the 38S PCB. This allows the heat sink tabs of Q2 and VR1 to be placed against the back panel for heat sinking. I used a Thermo Pad (also salvaged from old computer power supply!) for insulating the metal tab of the PA transistor, and a 4-40 nylon screw precludes the need for a shoulder washer as would be required with a metal screw. The 8V regulator needs no insulation. Trial fit the PCB in the case you use, and shorten the leads of Q2 and VR1 slightly to allow attachment to the rear panel without excessive lead length. Tack solder their leads in place, then remove the board and solder the leads well. A slight bend in the leads will help prevent failure due to flexing of the thin rear panel.

Center the PCB with the back edge held against the inside rear panel, and mark the holes for the bottom of the case. Drill four 1/8" holes after center punching the locations. To mount the PCB in the case, I used 1/4" long 4-40 machine screws installed from the bottom, and tightened against 4-40 nuts on the inside.

On top of these, I used some salvaged 4-40 screw locks from old computer DB-9 or DB-25 connectors. This is because the female portion of the computer hardware is too short to allow the 1/4" machine screws to tighten without bottoming. The 4-40 nut takes up this depth perfectly, and the result is the PCB that is almost level with the bent-up edge of the chassis sides where the cover mounts. Also, the rubber feet screws of the case are cleared with this hardware arrangement.

4-40 common nuts will secure all the male threads that pass through the PCB from the screw locks, except it is a little close at C29 near the antenna hole. I used a miniature 4-40 nut here also salvaged from a computer connector. These are getting a little hard to find now that most of today's connectors are nut-free, even if computer nuts are still plentiful! Threaded 4-40 spacers would work as well - I just had this hardware on hand.

I mounted all the connectors in a line

across the rear panel, except for the headphone jack which went in the lower corner below the paddle and straight key jacks. Resist the urge to use anything but a quality, silver plated 4-hole BNC jack for the antenna connector. Anything less is pure sacrilege to the QRP purest! I mounted mine directly above the mounting hole near C29 about 3/4" from the edge of the chassis.

And please don't use those cheap R/S SPST buttons for the TiCK mode switch! You won't like them! Get the best quality SPST switch you can find, and pat yourself on the back when you install it. I got some decent ones with metal sleeves under the button for a better feel and less "bounce". Quality C/K or Mountain switches are nice for this.

The front panel has the RF 1K pot mounted on the lower left, the main tuning 100K pot centered, and the 10K pot on the lower right. All of these pots are available from Circuit Specialists for $0.85 each, or from Mouser, etc. In fact, the ones I got from C/S were marked Mouser! I used as large a knob as possible for the tuning pot, and smaller ones for the RIT and RF gain. A sub-miniature SPDT toggle completes the RIT, and is mounted just above the RIT pot on my rig. The bottom switch lug connects to the 2nd and 3rd terminal of the RIT pot just below it. The center switch lead goes to pad # 15, and the top switch lead goes to pad # 14. The 1st terminal of the RIT pot (left, viewed from the front panel) goes to the same terminal of the tuning pot as pad # 17. Use the shortest leads possible for a neat connection.

I put a 27K resistor from wire pad # 17 to the ground foil near X3 to make the tuning more linear. A 5.6 uH choke for L1 allows tuning from 10.103 Mhz to 10.120 Mhz with the RIT mod on my rig. There is some slight chirp and drift when tuned to the lower end of the band I have yet to resolve, but above 10.106 Mhz it is free of this. Also, at the low end of the tuning range, the receive and transmit frequencies differ enough that the RIT needs to be turned to approx. the 3 o'clock position to stay on freq. with the other station.

Not much RIT range is had at the high frequency end of the tuning pot, since the 1N4004 is pretty much "stretched" to the minimum capacitance it can achieve. Note some 1N4004's are "better" than others. Try several to arrive at the best tuning range and least chirp at the low frequency end. Some have dispensed with the RIT control, or used saturated transistor switches to quell the chirp. I'll leave that option up to you. My second 38S I built without the RIT, and the tuning range was 10.100 to 10.122 Mhz with the stock 4.7uH RFC after sorting through several 1N4004s.

SUMMARY:

There are some shortcomings to a simple rig such as this one. More image rejection would be nice, but a two pole bandpass filter would also introduce some weak signal loss and additional complexity and alignment. The RIT range is very little at the high end of the band, and at the low end there is some frequency drift and slight chirp with the RIT from the manual. I noticed that touching the PA output filter or TC2 during transmit seemed to worsen this effect. Some further investigation is warranted here.

The keyed waveform is very hard, with near-vertical rise/fall times. This might not be possible to correct, as it is probably due to the digital nature of the 74HC240 chip. But it *will* key at high speeds without loss of character lengths, and it seems to punch through well when propagation is marginal. No one has yet complained about key clicks or the signal quality, so it doesn't sound as bad as it looks on a scope. The hard keying is actually an asset when keying at higher speeds, and it probably helps punch through the QRN and QRM.

If some of the mods are not done, the

74HC240 gets fairly unstable, and will emit "light saber" noises, and possibly self-destruct. DO replace D8 with a jumper, and perform the 5 watt PA mod. The rig just behaves better. The TiCK is essential to the overall performance of the radio, and you'll be much happier with it than without it. I'm going to get the TiCK-2 with its memory feature. It should be a lot of fun, especially when you have to call CQ a bunch on a poor band or late at night.

On the flip side, the rig has a lot of performance for a simple design. I find I have to reduce the RF gain frequently to reduce the headphone volume. And I can hear weak signals some of my other rigs can't hear! The transmitter seems to loaf along at 7-8 watts if you want it, and produces little heat with very little current demand. The finished rig can be as pretty as you want it, and it won't cost you a fortune. It is a complete radio with the keyer installed. The QSK is very good and fast, especially when "Mr.Thump" has been evicted! You'll be able to hear BK from the other hams easily.

I'm gathering the parts for Bill Jones' E-Dial, as seen on page 33 of the Spring 1997 issue of QRPp. Looks like a great add-on and the 30 LEDs will help locate your favorite frequency. It is an easy project, and just the thing to try your hand at PCB etching. If you plan to incorporate this, check your chassis size to be sure it will fit. The LA-4 cabinet mentioned above is a little too small for the E-Dial and control knobs.

Mechanical stability is excellent! It's a great mobile or trail-friendly radio! Surprising performance and small weight for an inexpensive kit. The quality PCB from Norcal along with the excellent manual and parts quality will make you not regret spending $25. And the knowledge you'll gain by building, debugging, and modifying can't be measured in dollars. A lot can be learned and improved upon by just tinkering with this great kit. Norcal, Ori, and a lot of others have helped to make this project more fun than I've had in years. Thanks everyone! See you on 30m! 72, AB7MY Gary Surrency

A Simple 80 Meter DC Receiver

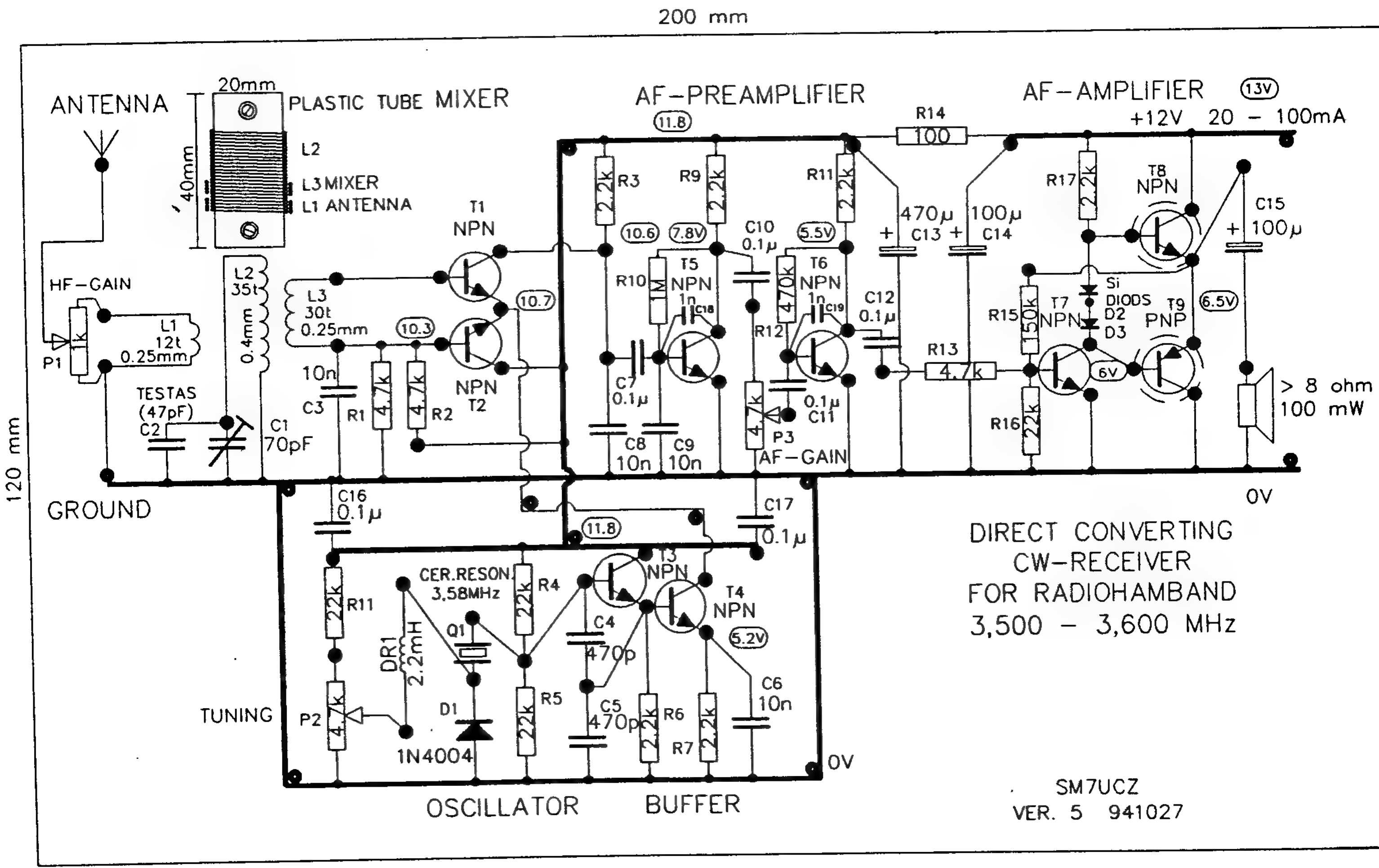
by Johnny Apell, SM7UCZ
Ekedalsvagen 11
S 373 00 JAMJO Sweden

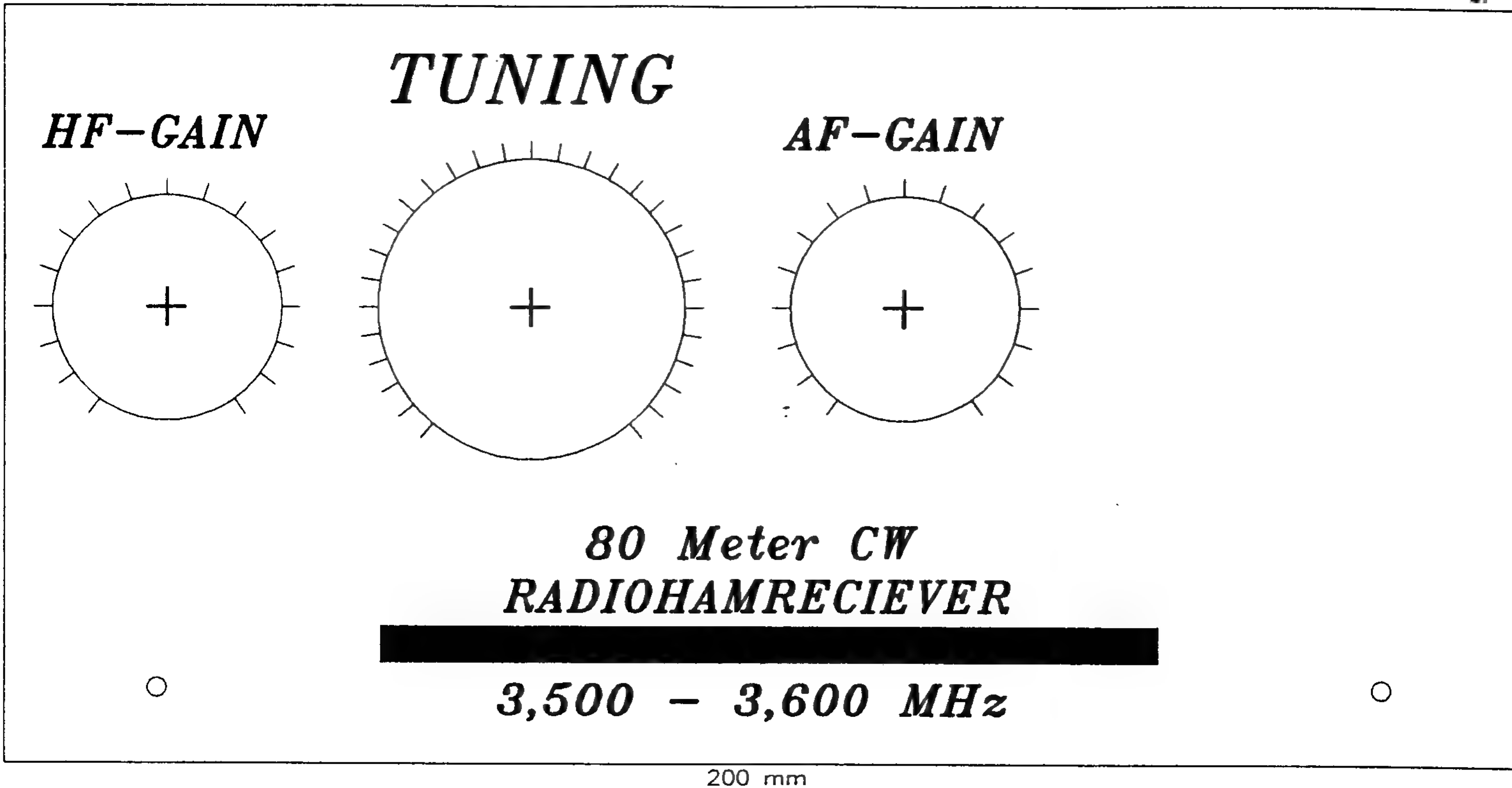
[Editors note: This receiver was first designed by Mr. Apell and submitted to George Dobbs for publication in D.I.Y. which was a publication aimed at beginning British hams published by the RSGB. Sadly, the journal is no longer being published. This summer I visited George and I was quite impressed by the simplicity and the reproducibility of the design. There was no text, just the schematic and front panel layout, but that is enough.

It uses the brass pin or brass nail approach. The builder will need to photocopy the schematic diagram on page 56 and then spray the back with adhesive spray. Then use a 1x6 board 8" long as the base. Attach the schematic to the board and then place the pins on the dark dots where indicated to use as connecting points.

I used a pair of pliers to hold the pins straight as I was pounding them in and also to act as a depth gauge to get all of them the same height.

The template for the front panel is on page 57 and can be made from aluminum or even thin wood paneling or plywood. Heck, even plastic sheet will work.
Thanks to George Dobbs for permission to print this design. I would be interested in seeing photos of any complete rigs. KI6DS]


200 mm
120 mm
ANTENNA
20mm
40mm
PLASTIC TUBE MIXER
L2
L3 MIXER
L1 ANTENNA
HF-GAIN
P1
1k
L1
12t
0.25mm
TESTAS
(47pF)
C2
L2
35t
0.4mm
C1
70pF
GROUND
L3
30t
0.25mm
10n
C3
R1
4.7k
4.7k
R2
10.3
T1
NPN
NPN
T2
10.7
AF-PREAMPLIFIER
11.8
R3
2.2k
R9
2.2k
R11
2.2k
10.6
7.8V
5.5V
R10
1M
T5
NPN
1n
C18
C7
0.1μ
C8
10n
C9
10n
C10
0.1μ
R12
470k
T6
NPN
1n
C19
4.7k
P3
AF-GAIN
0.1μ
C11
C12
0.1μ
R14
100
470μ
C13
100μ
C14
R13
4.7k
AF-AMPLIFIER
13V
+12V 20 - 100mA
R17
2.2k
T8
NPN
C15
100μ
R15
150k
T7
NPN
Si
DIODS
D2
D3
T9
PNP
6.5V
6V
R16
22k
> 8 ohm
100 mW
0V
C16
0.1μ
11.8
C17
0.1μ
R11
22k
DR1
2.2mH
CER.RESON.
3,58MHz
Q1
R4
22k
T3
NPN
T4
NPN
5.2V
C4
470p
C5
470p
R5
22k
D1
1N4004
TUNING
P2
4.7k
R6
2.2k
R7
2.2k
C6
10n
0V
OSCILLATOR
BUFFER
DIRECT CONVERTING
CW-RECEIVER
FOR RADIOHAMBAND
3,500 - 3,600 MHz
SM7UCZ
VER. 5 941027


TUNING
HF-GAIN
AF-GAIN
80 Meter CW
RADIOHAMRECIEVER
3,500 - 3,600 MHz
200 mm

QRP Rig Outputs on a Spectrum Analyzer

by Paul Harden, NA5N
120 Garden Circle
Socorro, NM 87801
NA5N@Rt66.com

FCC regulations require that QRP transmitters attenuate all emissions, other than the fundamental, by at least 30dB. Fortunately, nearly every QRP rig or kit I have tested has always met FCC compliance. This is mostly due to the careful design of the output filters. So builders have little to worry about (except to ensure you wind those toroids as specified!).

So what is -30dB, anyway?
30dB is a power factor of 1:1000. If your fundamental power is 5W, then your second harmonic would have to be a mere 5mW to meet the 30dB attenuation requirement. This may seem rather demanding, and it is. The accepted way to measure the fundamental and harmonic output powers of a transmitter is to use a spectrum analyzer. Since few people have access to one of these, the output spectrum of a couple of popular QRP kits are presented here, with some measurement notes for those who do have one.

Fig. 1 is an actual spectrum analyzer plot of the power amplifier output of a Wilderness Radio NC40a (but typical for any QRP rig) ***before filtering***, that is, at the PA transistor collector as shown in **Fig. 2**. It clearly shows the excessive power contained in the harmonics and the need for the output filters.

Reading a Spectrum Analyzer.
Fig. 1 is a typical display of a spectrum analyzer. In this case, a

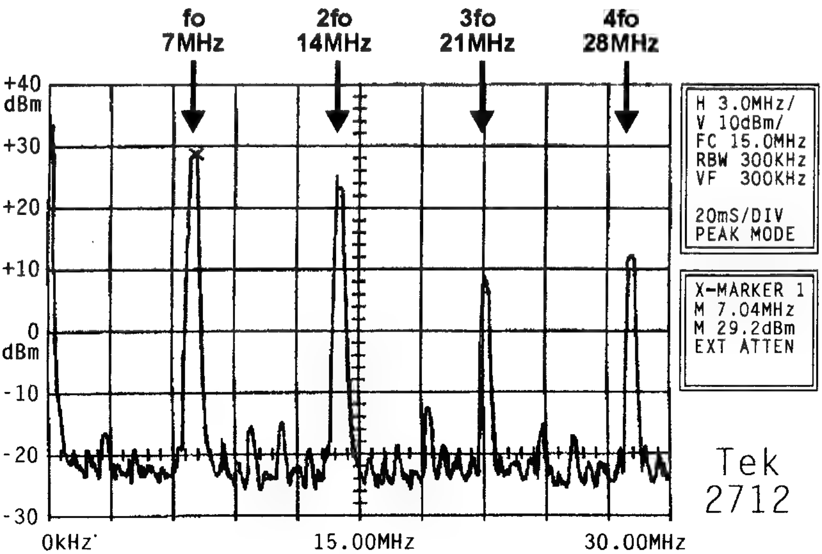


Fig. 1 - Typical output spectrum of the Power Amplifier (PA) transistor -- *before* any output harmonic filtering

Tektronix 2712 (a $38,000 machine) that makes a hardcopy of the display on a plotter. The instrument settings are listed on the right, which are:
H 3MHz/ = 3MHz/div. horizontal
V 10dBm = 10dBm/div. vertical
FC = center frequency of display
RBW = resolution bandwidth
VF = video filter in use
20ms/DIV = sweep speed
PEAK = normal power mode
X=MARKER 1 is the "X" on the 7MHz spectrum, and shows it is at 7.04MHz and the peak is 29.2 dBm = a bit less than 1 watt.
Tek 2712 = built-in advertising!

On most spectrum analyzers, these instrument settings are read directly off the front panel controls and displays. Also note that **EXT ATTEN**uation was used. This is because most spectrum analyzers tolerate a maximum input power of +20dBm (100mW). Beyond that, you will likely blow the input amplifiers. I use an external 20dB attenuator (or directional coupler) so that +37dBm (5W) is actually +17dBm input ... and so should you.

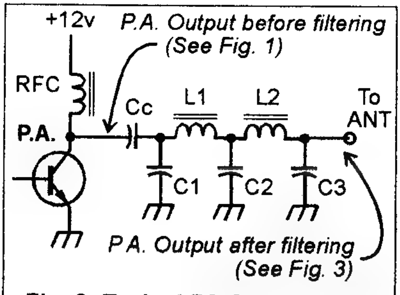


Fig. 2- Typical PA Output Stage

The output filter is a low-pass filter to attenuate everything above the fundamental. (It also matches the impedance of the transistor to the antenna). **Fig. 3** shows the output spectrum of the NC40a ***after*** the output filters. At 10dB per division, the 2nd harmonic is clearly 30dB attenuated, meeting FCC specs. One can also determine the roll-off the low-pass filter from this display, as shown by the dashed line in Fig. 3. In this case, 14MHz is attenuated by 34dB ... in filter terminology, this is a *34dB per octave roll-off,* fairly respectable for a 2-pole filter. Note the frequency span in Fig. 3 is less than that shown in Fig. 1.

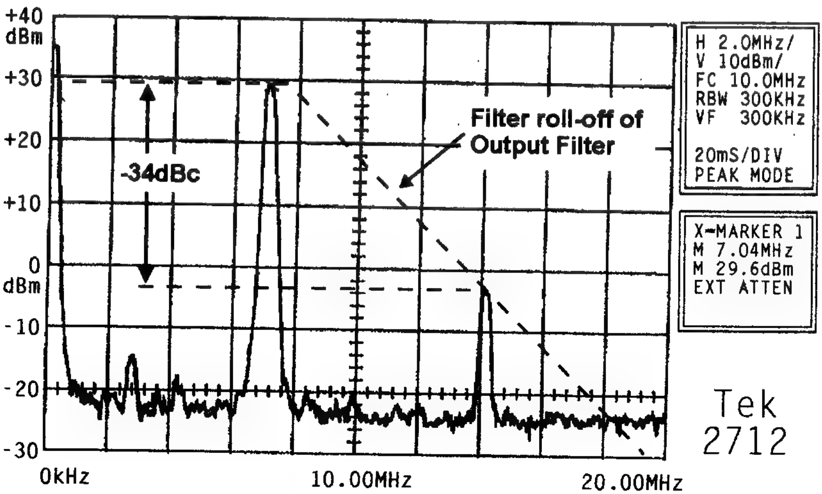


Fig. 3 - Typical output spectrum *after* output filtering

So when you see the output filter specs listed as "2nd harmonic -30dBc" (below the carrier), it will look just like Fig. 3, with the harmonic peak at the level cited.

38-Special Output Spectrum
Various attempts have been made to describe the 38-S output in the last QRPp and on QRP-L. Well, here it is in black-and-white. The "stock" 38-S (no IRF510) has a clean output spectrum. **Fig. 4** is the 38-S with IRF510 installed, no mods, and TC2 misadjusted - causing a ~250KHz oscillation and 2nd harmonic that exceed -30dBc FCC specs. Some of this is due to an impedance mismatch in the output filter when using the IRF510. The filter mods published by K1MG and myself normalize the filter impedance to the IRF510 for a 10-12dB improvement in the rejection of spurious emissions, as shown in **Fig 5**. The wideband power below 10MHz is unusual and seems to be an effect of paralleling the HCT240 drivers with the IRF510, but meets FCC specs (with output filter mod) and TC2 adjusted for a pure sidetone.

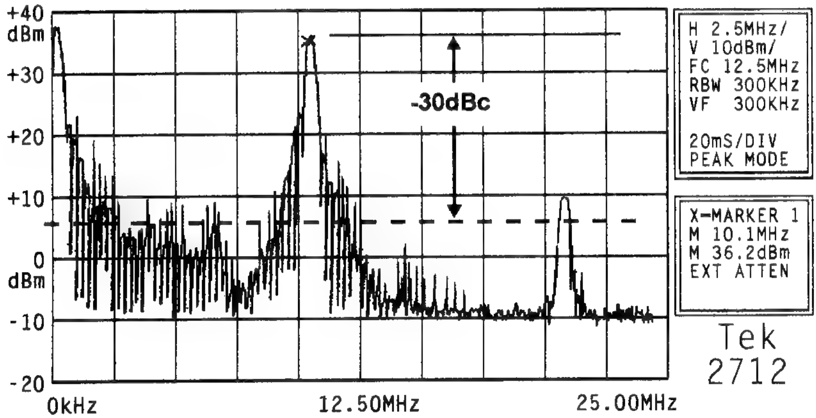


Fig. 4 - 38-Special Output Spectrum with IRF510, no mods, and TC2 misadjusted

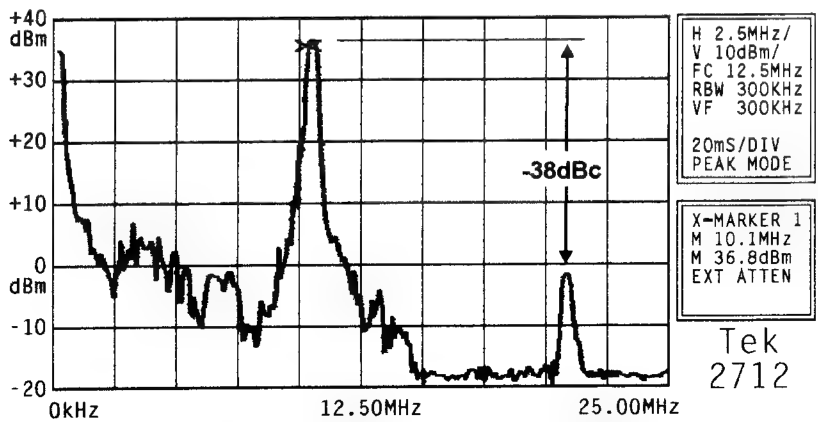


Fig. 5 - 38-Special Output Spectrum with IRF510, TC2 properly adjusted, and K1MG/NA5N Filter Mods

QRP HINTS & KINKS

A NorCal Exclusive

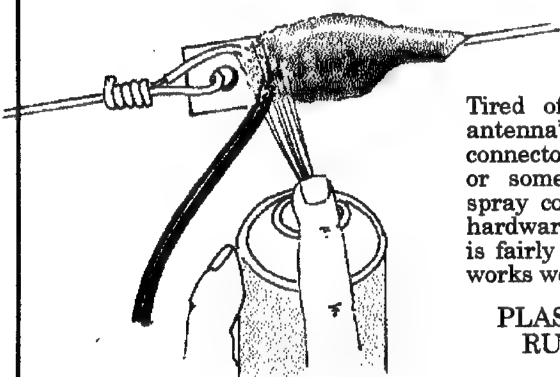
Illustrated by Paul Harden, NA5N (NA5N@Rt66.com)

#5 Hints & Kinks from "the mail bag"

Most of the *QRP Hints & Kinks* in this issue are those received from "the mail bag," via email, or as shown to me at hamfests by fellow QRPers. They are all pretty nifty, as I'm sure you'll agree. Thanks to all for the great ideas and submissions.

#1: An EASY WATERPROOFING TECHNIQUE

From Mike Wood, K6MW



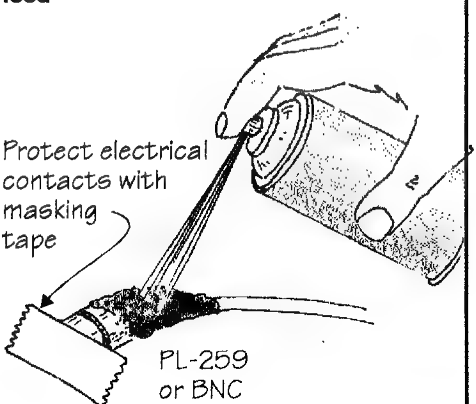
Waterproof sealing the center-feed of a dipole antenna

Tired of trying to waterproof antenna's or outside coaxial connectors with electrical tape or some gooey stuff? A new spray compound found in most hardware stores, WalMart, etc. is fairly cheap ($3-4 a can) and works well. It is called:

PLASTI-DIP SPRAY-ON RUBBER COATING

Other applications might be:

- Spray on the bottom of morse code keys/paddles for an anti-skid surface.
- Seal your W6MMA St. Louis Vertical coil (except for slider area)
- Sealing toroid coils or baluns
- Repair rubber duckies
- Waterseal coax holes thru windows, metal or for mobile automobile installations
- Really neat graffiti

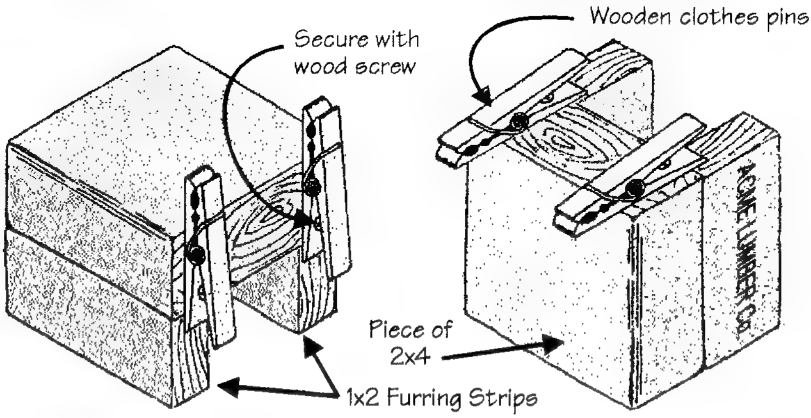


Waterproof sealing a coax connector for outside use

#2: The AMBIDEXTROUS THIRD-HAND

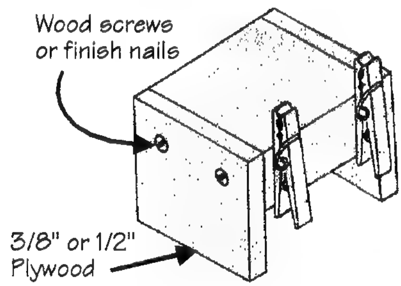
from Baity Bartel, W2LQ (Denton, TX)

Here's a quick project proving that sometimes the simplest projects can be the most useful ... and best of all, the estimated cost to build is 10¢ (maybe 25¢ in some localles). Looking at this simple approach, one can immediately see all sorts of variations to suit one's individual needs.

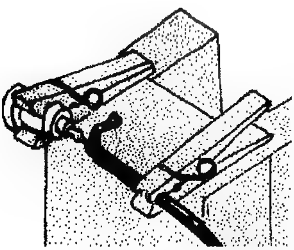


Left-hand or Vertical Usage **Right-hand or Horizontal Usage**

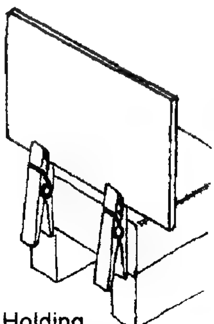
The 1x2 furring strips can be affixed with wood glue or recessed wood screws. An alternative approach is shown to the right, using two pieces of plywood cut to the same size. Making it square on all sides, like a box, makes it very useful by positioning it in different configurations.



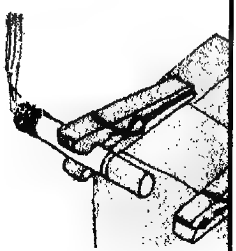
SOME APPLICATIONS . . .



Assembly jig for cables, wiring and soldering connectors



Holding circuit boards, panels, etc. for assembly, soldering or painting.

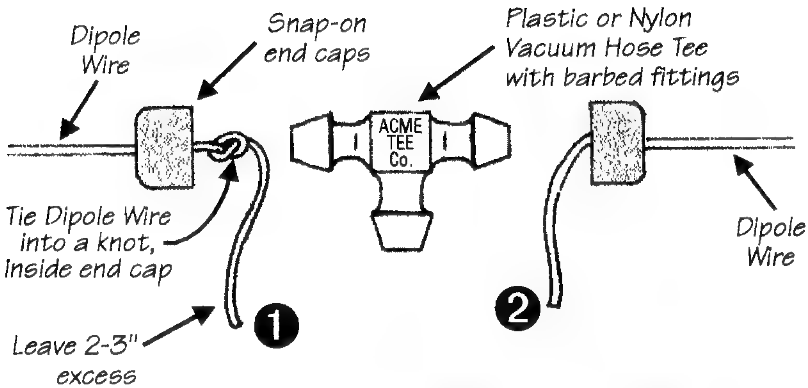


Cigarette holder (In the 60's, known as a "roach clip")

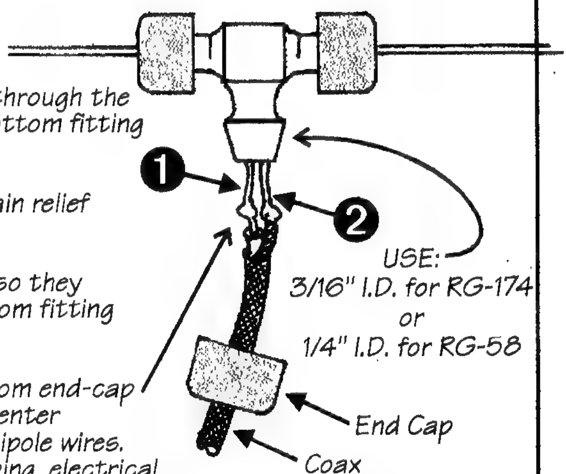
#3: The MINIATURE "To The Field" DIPOLE

from Roger Yoakum, WD6CLJ

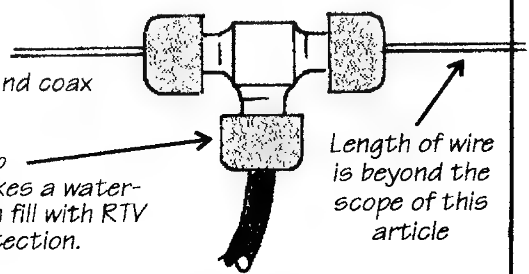
Here's a neat dipole you can make and take with you, rolled up in a sandwich bag or your back pocket. The dipole center insulator is based on a plastic or nylon vacuum-hose "T." These are a $1 item at most auto supply stores, hardware stores, Small Parts Inc., etc.



- Pull excess dipole wire through the vacuum tee through bottom fitting
- Snap-on the end caps. These serve as the strain relief when dipole is raised.
- Cut dipole wire excess so they protrude through bottom fitting by about 1/2"
- Run coax through bottom end-cap and solder shield and center conductor to the two dipole wires. Insulate with shrink tubing, electrical tape, etc.



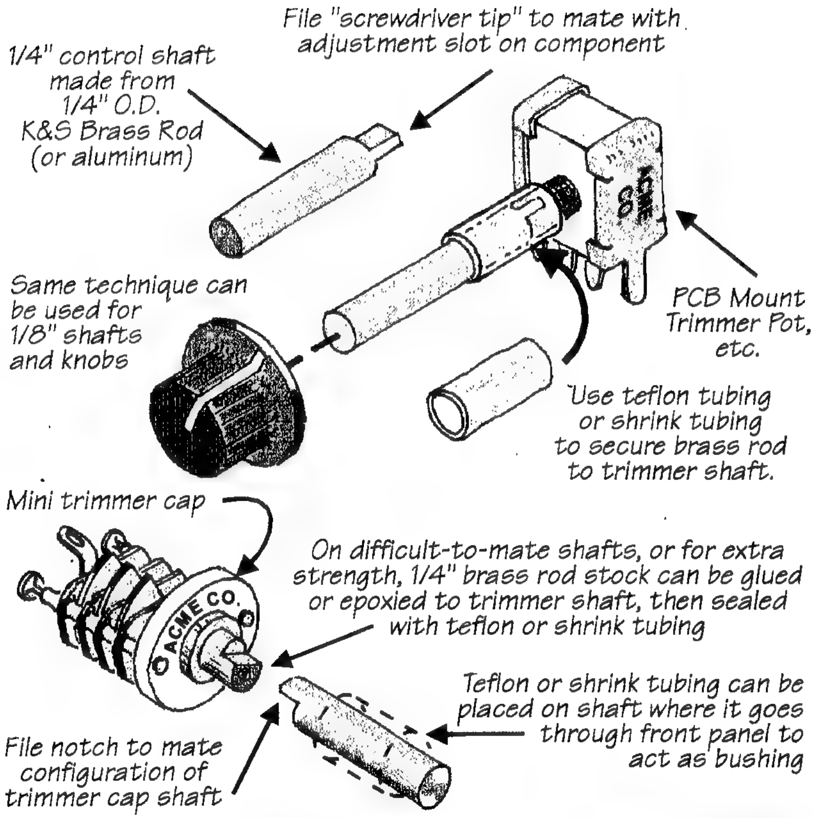
- Push excess dipole wire and coax into vacuum tee body
- Snap-on bottom end-cap (with the coax). This makes a water-proof dipole feed. You can fill with RTV or hot-glue for extra protection.



#4: MAKING CONTROL SHAFTS FOR TRIMMERS

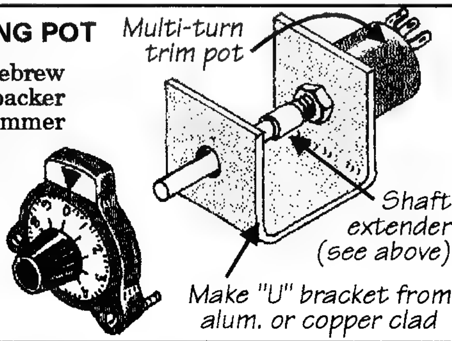
From Peter Simpson, KA1AXY

Hamfest parts bins are full of trimmer pots and miniature variable trimmer caps that are great for QRP projects. But often we need to use these parts (particularly the trimmer caps) as a front panel control. Here's a couple of suggestions on how to add control shafts to these components.



The KA1AXY 10-TURN TUNING POT

Peter, KA1AXY, built this homebrew 10-turn tuning pot for a backpacker rig from a surplus 10-turn trimmer pot, adding the shaft as above, and using a turns counting dial. If using a single turn pot, an 8:1 vernier dial should be used for the front panel dial. Both dial types are available from Mouser.



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Back issues of QRPp are available in bound volumes only. They are bound in 1 year sets with a plastic finger binding and have a heavy card stock cover. Sets will not be broken up, and are available in 1 year sets only.

1993 - $10	1994 - $15
1995 - $15	1996 - $15

Shipping:
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Canada $3 for 1 issue, $5 for 2 - 3 issues, $7 for 4 issues.
DX Europe & South America, $5 for 1 issue, $7 for 2 - 3 issues, $10 for 4 issues
DX Pacific Rim, Australia & New Zealand, $5 for 1 issue , $10 for 2 issues, $15 for 3 issues, $20 for 4 issues All funds US funds only. Make check or money order to Doug Hendricks, NOT NorCal. Please send orders to:

Doug Hendricks
862 Frank Ave.
Dos Palos, CA 93620

NorCal T Shirts Now Available

Jerry Parker, WA6OWR, is now making available a NorCal T-Shirt. The price is $15 plus $3 shipping in the US, $5 shipping for DX. The shirt is a high quality heavy duty shirt imprinted with a large NorCal Logo across the front. Check the NorCal Web Page for Pictures, as they were not available at press time. The address for the NorCal Web Page is:

http://www.fix.net/~jparker/norcal.html

The shirt is gold with the NorCal Logo in black. To order Send $15 + $3 postage ($5 DX) to:

Jerry Parker
426 Tanglewood Ct.
Paso Robles, CA
93446

Don't forget to specify your size: M,L,XL, XXL (Note XXL shirts are $3 additional) Make check or money order out to Jerry Parker, NOT TO NORCAL, US Funds Only

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Amanda Wines Memorial Cover
GL in becoming a Veterinarian
-- NorCal Production Staff

QRPp

Vol. V, No. 4

Winter 1997

The NorCal K8FF Paddles

Journal of the Northern California QRP Club

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From the Editor

by Doug Hendricks, KI6DS/M0BIV

Season's greetings to all of our members from all of us at NorCal. We are finishing the 5th year of publication with this issue, and now have published 1,304 pages of QRP information. That is amazing and the credit goes to the members who have made my job very easy to do with your prolific contributions. Thank you.

Now for some house keeping. Frank Brumbaugh sent me a correction for a mistake that was in the last issue. In his article, **Accurate QRP Power Measurement**, he gave the wrong formula for figuring power. It had an extra square root sign. The formula should be: $(.707\ E\ PK)^2/$ 50 ohms (or the value of the dummy load). Both Frank and I apologize for the inconvenience caused.

Pacificon was a wonderful event this year. All of the speakers were top notch, and everyone enjoyed their presentations. The building contest Saturday night was unbelievable, and you have to take a look at the pictures on the NorCal Web Page, http://www.fixnet/norcal.html to see all of the great fun that we had. Jim and I were also honored to be selected as the ARRL Pacific Division Hams of the Year for our work with QRP and bringing the QRP Forum to Pacificon. On behalf of Jim and myself, I would like to thank the ARRL, the Pacific Division Director, Brad Wyatt, and especially Sid Furman and Chuck Adams, NorCal members who nominated us. We both appreciate the honor.

Next year Pacificon will move to a bigger hotel with much larger conference rooms. The QRP Forums certainly need one, as all of our sessions were filled to overflowing. We hope to see you there.

Lots of exciting things are happening in QRP. One of the most exciting has been the announcement of the NorCal Sponsored 2N2222 building contest for Dayton. See page 4 for details of this as well as the other two contests, the K5FO Unlimited, and the K8FF Paddle contest. There are a couple of articles that were prepared in record time by Glen Leinweber and Steve Weber that should give you a lot of help towards building something for this contest. See Steve's article on page 38 and Glen's on page 26.

You will note that this issue is 84 pages, another larger than normal issue. The reason? Well, I couldn't chose which article to not print, they are all so interesting, and we have the funds, so we went to the "fat issue format" this time. Plus this is the holiday season, so consider it a "holiday bonus" from NorCal.

I would also like to mention that we now have an agent to handle UK and European subscriptions. Steve Farthing, has agreed to be NorCal's agent for subscriptions and club kit purchases. The UK subscription price is 12.5 pounds, Sterling payable to Steve per year for airmail delivery of QRPp. Hopefully this will make it more convenient for UK and European members to receive QRPp. See Page 83.

In early November I suffered a disk crash caused by a virus that destroyed most of my files. I had this issue 80% finished, and had to do it all over again, not a pleasant thought, but my fault for not having it backed up. The bad part was that I lost about 180 new members and renewals, of which I have been able to recover 103. If you sent in a renewal or new membership and have the wrong renewal on your mailing label, please let me know and I will make the correction. We are having 77 extra copies of QRPp for Winter 97 printed and will mail them to missed subscribers as we discover them. I apologize for the inconvenience. I now have a virus checker and a Zip Drive back up system on my computer, but the horse has already escaped from the barn.

Please check your mailing label for expiration date of your subscription. The cut off for the Spring issue is Mar. 1. 72, Doug, KI6DS/M0BIV

Dayton Building Contests sponsored by NorCal QRP Club

This year at Dayton, NorCal will sponsor 3 separate building contests. They are:

NorCal K8FF Paddle Contest

This contest is for those builders of the NorCal K8FF Paddles, designed by Wayne Smith, K8FF. There will be 3 prizes.

K5FO Unlimited Building Contest

This is an open contest for anyproject that you have built in the past year. Please include a 1 page summary of your project, typed, double space giving details of your project, mods, features, etc. Only projects built since Dayton 1997 are eligible. If you built it, it is eligible. Must be QRP related. 3 Prizes.

2N2222 Building and Design Contest

Wayne Burdick, N6KR came up with this one and the rules are simple. Design a transceiver that uses no IC's, no prepackaged mixers (SBL-1's, Plessy 6440's etc), only no more than twenty-two 2N2222 transistors as active devices. Any type of diode may be used. Entry must be accompanied by a typed description and a schematic on 8.5 x 11 paper (as many pages as it takes). If you borrow circuits previously published, please list the source. 3 Prizes

Judging for all contests to take place Saturday night at 8:00 PM of the Dayton Hamvention at the QRP ARCI Hospitality Suite. Judging by K5FO and his team of judges. Entries may be made by proxy.

1998 QRP to the Field
"Run to the Borders"

The third annual QRP to the Field Contest sponsored by the NorCal QRP Club will be held on Saturday, April 25, 1998. The objective of the contest is to operate from portable field locations with a maximum of 5 watts of power. Home operation is permitted but contacts made from the field are worth a 4X multiplier, while home operation contacts are worth 2X multiplier. The theme for this year's contest is operating from borders.

As such, any station that operates from a border of a state or country will get credit for an extra multiplier per state or country border operated from. For example, if KI6DS operates from the California - Oregon border, he would get a 2X multiplier for each contact, but he must give a signal report from each state, i.e. 579 CA, 579 OR. The station working KI6DS would get state credit for each contact, 1 from California and 1 from Oregon. If you were working from the California - Arizona - Mexico border your report would be 579 CA, 579 AZ, 579 XE, and the border station would get a 3X multiplier per contact. The theme this year should help in the WAS QRP award hunt but you must have a separate QSL for each state for the ARRL award.

Contest Period: 1600 UTC to 2400 UTC (9AM - 5PM) PDT.
Exchange: RST and State, Province or Country (Border stations must give a separate RST for each state, province or country.)
QSO Points: 5 points per QSO (No Dupes). Stations working border stations get 5 points per report, and should log each state separately.

17:54 KI6DS 599 CA
17:54 KI6DS 599 AZ
17:54 KI6DS 599 XE

Multipliers:

Field Location - 4X (Field = Battery power & Tempory antennas)
Home Location - 2X (Home = commercial power and/or permanent antennas.
SPC (State/Province/Country) totals for all bands. Count SPC once per band. The same station may be worked on more than one band for QSO points and SPC credit.

Final Score: Add QSO points, multiply by location, multiply by SPC total.
Awards: Top Ten Scores Certificates
Send a copy of your log along with the station description (rigs, antenna, etc.) plus location description to: Joe Gervais, NorCal Contest Manager, P.O. Box 1822, Goodyear, AZ, 85338 or via email at: vole@primenet.com

An entry not having the Station & Location descriptions will be considered a check log, without scoring. Please get them in by June 1st, 1998. All contest committee decisions are final. Results will be published on QRP-L and in QRPp, the NorCal QRP Club Journal. How close do you have to be to a state border to claim operation from a state? Use common sense here and do not do anything that would endanger yourself. This contest, as are all contests, is on the honor system. We trust you. The object is to have a good time. Good luck and see you in the contest. 72, Joe, AB7TT

HW-9: The (nearly) Complete Guide to the Mods

by Gary Surrency, AB7MY
gsurrency@juno.com

The HW-9 is a fine rig. However, it *does* have some problems as delivered by Heath. In this article, I hope to show to improve the performance of the -9 and encourage others to try their n hand at problems areas that their rig may exhibit. Feel free to contact me with your own mods, or any questions that this material may create. I will address a number of problems that my HW-9 had.

Please note that I find Molex IC pins to be invaluable when substituting components, as they can be individually installed for transistor, diode, capacitor, or resistor sockets. This saves damage to the PCB, and allows me to try different devices without reaching for the soldering iron each time, or removing or replacing the PCB between tests.

These socket pins come on a "tree" carrier that you can use for various IC pin counts, and are separated normally by snapping off the "tree" after installation. When used individually, they are a little more difficult to get installed straight without burning your fingers. I use a 1/4 watt resistor as a holding tool as I solder the individual pins.

VOLTAGE REGULATOR

Change U402 from a 78L08 to a 78L09 regulator, and replace D409 with a jumper wire. This will give you a nice solid 9 volt regulated supply with better regulation and slightly cooler operation of U402, as it isn't dropping as much voltage. I thought I could hear a very slight "chirp" on the transmitted signal before I made this change, and the original setup only provided about 8.6 volt with the diode in series with the regulator's ground pin. The diode is *not* in the error feedback loop of U403, so the regulation is not what it should be. The additional few tenths of a volt and better regulation are welcome in the VFO, second IF filter / amplifier, and AGC circuits.

Notice that as Heath designed the radio, the BFO isn't operating from a steady regulated source. Many critical circuits in the rig are powered direct from the poorly regulated 12 volt main supply, rather than an accurately regulated source. I will later describe mods to the PSA-9 power supply to correct poor regulation that can also contribute to frequency shifts during transmit. If you use a different power supply to run the radio, be aware that its stability under load needs to be good to keep the signal from chirping, as the BFO and HFO do not like an unsteady DC source. Frequency stability from these circuits is crucial to signal quality.

KEYING

The first thing I noticed when I received my HW-9, which I did not build, was that the keying was pretty soft. This was especially true when looking at the trailing edge of the keyed waveform on an oscilloscope. There was just too much of a "tail" on the key-up portion of the envelope. Although the HW-8 Handbook has some ideas on correcting this problem, I chose my own method, and it is simpler.

It seems that capacitor C578, a 47uf electrolytic, is way too large in value. I found I never needed to turn the Mute Delay control anywhere near its maximum, and so I began to examine this part of the schematic for ideas. By simply changing C578 from 47 uf to 10uf, the key-up waveform edge became much shorter. After this change, I still have plenty of Mute Delay for all practical purposes, but I noticed the shortest setting of the control permitted a little T/R click to pass into the audio chain. It seems the large 47uf original value for C578 delays the turn-off characteristics of the keyed line.

By changing R444 from 180 ohms to

1500 ohms, the proper range of Mute Delay is preserved, and the T/R click is eliminated. There is a click at full audio gain, but this seems unrelated to the Mute Delay time constant. It may be due to the DC coupling from U306 to Q303, but I don't think it is significant unless you are hard of hearing and like to run your audio gain full tilt!

I also observed the leading edge of the keyed waveform is a little fast on rise time, and sounds kind of "hard" when monitored on a local receiver. A quick improvement for this behavior can be had by changing C435 from 2.2 uf to 4.7 uf. The rising edge of the keyed RF waveform is a little slower now and sounds better. Try several sizes of caps if you want to see what affect it will have.

RECEIVE SENSITIVITY

Heath has always tended to use the MPF105 junction FET in a lot of their kits. This device has a very poor transconductance, as mentioned in an article I read in 73 Magazine on "How to Make a HW-8 Come Alive", May 1996, by Gerald F. Gronson K8MKB. As he said, Heath couldn't have chosen a worse device for the RF amplifier in the HW-8. "A coupling capacitor would be a better choice than a MPF105", he writes.

This is also true for the IF amplifier preceding the crystal filter in the HW-9. Again, using Molex socket pins, I tried a number of FETs to see what could be achieved. Many higher gain FETs, such as the J310 and J309 seemed to have too much gain, and caused oscillation and instability without redesigning the entire amplifier stage and it's biasing, termination, etc. So I settled on a MPF102 (R/S pn. 276-2062, $0.99) chosen from a number of devices I had on hand. A good increase in sensitivity is the result, and I used the current measurement through source resistor R305 as a guide to selecting a proper candidate. I also monitored a weak signal on the rig's S-meter for best signal strength as I chose the best device..Re-adjust T301 and the AGC threshold control, R329 after making this substitution as described in the manual for proper S-meter behavior. Use care and a proper tool to tune the slug in T301 so it does not crack or crumble.

AUDIO IMPROVEMENTS

The HW-8 Handbook mentions that capacitor C336, a 2.2 uf electrolytic, is installed backwards for polarity. It should be reversed from what is shown in the manual, schematic, and PCB silk-screening. If you like, you can try a slightly larger cap for C336 (using Molex pin sockets!) to see if the audio quality is improved. I kept the original cap but turned it around.

A mention is made in the HW-8 Handbook about substituting a TL084C quad FET op amp for the LM324 used at U304. This is supposed to retain the high impedance of the active audio filter and is claimed to be a quieter device. I had some TL084C ICs, so what the heck? I did not see a noticeable improvement, but if your audio filter seems noisy or if the bandwidth is not what you think it should be, give it a try.

I noticed the active audio bandpass filter center frequency is not the same as the crystal filter's center frequency. I still have to address this problem, but if your rig seems particularly poor in this respect, check R354 and R359 to see if they are close to 1.5 megohms and matched in value. C339, C341, C344, and C345 all need to be matched in value for best filter performance. Heath used ordinary ceramic disk caps for these, and they have only 20% tolerance or so. Use a capacitor meter if you have one, and select four caps that are as close as possible to use in the filter. If you don't have enough of these, remove several other .001uf disk caps from other places on the T/R board and select the four best candidates. Use the fall-outs for the other caps, since their circuits are not as critical.

Polyester or mylar caps have normally better tolerance, stability, and leakage than the ceramic disks used, so if you can get them - use them. I think the audio filter's center bandpass frequency should be shifted slightly lower than it currently is, so .0012 or .0015 uf caps might be a better choice here. I prefer not to parallel or series connect several components to get the value needed, so some parts searching is in order.

Using 1.8 megohm resistors for R354 and R359 might do the trick, but I haven't done the math or tried them since I didn't have any in my parts bins. Most other audio filters I have encountered do not use such high R and small C values. All new values for the filter might be the way to go, but the existing filter works pretty well - even if it is too high in center frequency for the crystal IF filter and my preferences. The S-meter and audio filter should peak on at the same frequency.

TRANSMIT STABILITY and POWER OUTPUT

I had no complaint about the output power level of nearly 7 watts maximum on bands 80m through 15m, but 15m seemed a little unstable. On 12m and 10m, the output was down slightly to 3 watts or so. On 15m, the CW Level control seemed to be non-linear when increasing and particularly *decreasing* the power level. I suspected some spurious behavior of the driver or PA stages. It turned out to be in the pre-driver stages.

In the original design, Heath used MPS6521 transitors (Heath pn. 417-172) for Q401 and Q402, the pre-drivers that precede Q404. Q404 is a 2N3866 (Heath pn. 417-205) that is more than adequate in power gain and frequency. However, there are ferrite beads on the base leads of Q401 & Q402. I have found this to usually indicate a problem area that needs addressing, rather than taking a Band-Aid (tm) approach!

Sure enough, here is where the instability and loss of power output on 12m and 10m was found. If your rig's output level drops suddenly from a constant level as you reduce the CW Level control - especially on 15m for some reason - then you need to look into this.

After installing Molex pin sockets on Q401 & Q402, I began the tedious search for transistors that were both more stable and had greater output on the two higher bands. After trying perhaps 100 devices of maybe 5 or 6 types, I finally found the right combination. Q401 seems to be not as critical as Q402 is, and almost any PN2222, 2N2222a or MPS2222a will work fine for Q401. However, Q402 is a different subject entirely. Nearly every flavor of xx2222x device I tried caused spurious output and instability - especially on 10m. The ferrite beads offered no help in reducing this problem.

I finally found (after some mumbling and cursing) 1 or 2 2N3904 transistors that behaved well and gave decent output on 10m. Many of the 2N3904's I tried were simply "too hot" and caused a spur on the transmitted waveform between 3 and 5 watts output. The OHR WM-1 wattmeter also indicated a sharp increase in output level, due to increased harmonic / spurious output. The extra "trash" on the transmitted waveform was easily noticeable.

Apparently, without major changes in the circuit design, about 4 or 5 watts on 10m is the greatest output level that can be produced without excessive spurious content. I settled for this, using a prime MPS2222A (R/S pn. 276-2009, $0.59 ea) for Q401 and a MPS3904 (R/S pn 276-2016, $0.59 ea) for Q402. If you have several different manufacturing brands for the 2N3904 device, try them. Some behave quite differently from others, and you need to find one that is not too "hot" but has decent high frequency performance. Expect to spend some time trying quite a few before you find the *correct* device, and the Molex pins or sockets are a must for

this selection process.

Note that the ferrite beads were of no help in reducing the spurs, and are *not* required with the transistors I recommend. The 2N4401 part mentioned by some was a poor performer compared to the 2N2222A / MPS2222A and 2N3904 / MPS3904 combination for Q401 and Q402, respectively. My final choices were *both* made by Motorola: Q401 is a MPS2222A and Q402 is a 2N3904, although Radio Shack lists it as a MPS device, it is actually branded as a 2N3904 device.

The final result is a broad range of adjusting the CW Level Control will produce from 7-8 watts on 80m through 12m, and about 4.5 to 5 watts on 10m, depending on the VFO setting. No instability or sudden changes in output level occur on any band, as it should be.

As mentioned in the HW-8 Handbook, I use and recommend NTE401 heat sinks for long life of the MRF237 PA transistors, especially if the ambient temperature is high (as in AZ on BUBBA day!) or if you enjoy long tune-ups, 5 watt operation, or rag-chewing. They will just fit if you adjust the position of T403 slightly. Use a small amount of thermal compound before pressing the heat sinks into place. The bandswitch shaft will just clear the new heat sinks that have one more fin and are slightly larger in diameter than the old ones. Use one of the original heat sinks on Q404 if you like (it's not really needed) and rest confidently that the PA transistors Q405 & Q406 are much cooler in operation. Be safe and hold the output level at 5 watts maximum.

I'm curious as to why Heath didn't design the PA stage as a push-pull output, as it is almost as simple as the parallel PA design they used. One day I might try to change it to push-pull as that would insure the two transistors share equally in the load, and second-order harmonics would be even less. Some biasing changes might be necessary, but the parallel scheme works just fine, although if the two MRF237's aren't pretty close in characteristics, one of them will "hog" more of the load than the other. If your rig's output is low on all bands, one MRF237 is probably toasted.

AGC MODS

The AGC is too fast for my tastes, and the S-meter tends to beat itself to death on CW signals as it jumps up and down on every CW character. There are a couple of ways to slow the AGC and S-meter operation. Either decrease the value of C317, a 3.3 uf electrolytic; or increase the value of R312. Or, do both! I decided to simply remove R312, a 47k 1/4 watt resistor that is the primarly discharge path for C317. This slows the AGC and S-meter quite a bit, and is easy to do. C317 then discharges through R311 and R309, as well as R316 and IF amplifier U301. Some discharge also occurs by way of D306 and the S-meter FET amp.

While trying several caps for C317, I found a 33 uf cap produced about what I wanted for the AGC time constant / S-meter behavior. But I concluded such a large value of capacitance might load the AGC output level of U302, causing a loss of proper attack time and AGC peak voltage level. I therefore decided on removing R312, which produces about the same affect on AGC time constant with no additional loading of the AGC circuit.

TRANSMIT / RECEIVE TRANSITION IMPROVEMENTS

Much of the improvement of the T/R switching is achieved by the mods to the keying circuit mentioned earlier. However, some additional improvements can still be had by addressing the receiver muting. Transistor Q303 is a MPSA20 (Heath pn 417-801) general purpose device. It lacks the low ON saturation voltage and switching characteristics needed in muting the audio input to U306, the AF power output amplifier.

Using Molex pins again, I tried a large

number of NPN transistors for Q303. Most of the high gain, low VsatON devices performed better muting of the audio line and helped reduce the small T/R pops during fast QSK settings of the Mute Delay adjustment pot. Believe it or not, the best device turned out to be a spare Heath transistor I had for my SB-104A transceiver! It is a Heath part number, 417-233, or a 2N3643.

If you can't find something similar, look for a high beta audio transistor with 600ma to 800ma maximum collector current rating. The NTE replacement guide shows a NTE128 as a possible part. Run the audio gain at near maximum while keying the rig at the shortest Mute Delay settings to find the quietest transistor. Note that you should *not* turn the AF gain to its maximum setting, as this will induce another T/R pop that is practically impossible to eliminate without further modifications. This was mentioned earlier in the section on KEYING mods.

It is also *not* necessary to increase the CW Level so that the rig is transmitting, unless you think the additional current draw might introduce more T/R noise. I did not notice this with my rig.

I should mention that a 2N7000 TMOS FET could be used as a muting transistor, but unless a discharge resistor is added from the Gate to ground, once the Mute signal is applied to the 2N7000's Gate, it will "latch" and not turn off during the return to receive! I tried a 2N7000 on mine, and although it worked well at killing the audio pops during Mute, I decided the 2N3643 worked just as well and did not require another resistor as the 2N7000 would. Several mods have appeared in various publications about putting a series Mute FET in the audio lead to the input of the AF power output IC, but this requires more effort and modifications than just finding the "right" muting transistor for Q303.

HELP FOR THE BFO, VFO, ETC.

If you still can't get enough output on your rig after doing the pre-driver mods for Q401 and Q402, you might have low output from the BFO circuit. Note on the schematic how the output level of the BFO is varied by the CW Level Control on the front panel. Diode D143 is used to shunt a portion of the BFO signal to ground before it is introduced into the SBL-1 bilateral diode ring mixer. This is a rather unconventional yet effective way to control the transmitted power level.

Since Heath commonly used the MPSA20 (Heath pn. 417-801) device in many kits and circuits such as the BFO in the HW-9, I figured it was probably not the ideal device for RF applications. Once again, some improvement can be gained by selecting a better device for some of the BFO stages. There are a couple of choices here to obtain increase BFO drive - both for the transmitter stages and also for the receiver's Product Detector. You can either pull out several of the Heath 417-801 transistors and select the best ones for critical circuit locations, or use another device altogether if you don't mind replacing the original Heath parts.

Since I had some Heath 417-801 spares for my SB-104A rig, I decided to pick a few of them for the BFO that gave me the most output without making any other changes. If you remove several 417-801 transistors from your HW-9, you can select the ones that perform best where they are needed. Otherwise, use MPS2222A, 2N2222A, or 2N3904 transistors that are widely available.

Using Molex pin sockets for Q113, Q114, and Q115, try several different transistors for the greatest and cleanest output of the BFO. Monitor the BFO level using the Heath provided RF detector at test point TP104, and /or the S-meter during transmit as it monitors relative power ouput. You should not increase the BFO's output to the point that spurious output is developed from overdriving the SBL-1 mixer

and succeeding transmitter stages. You wouldn't want to undo all the work just done in the pre-driver stages by applying too much BFO injection!

I found a couple of 417-801 Heath transistors that were much better than the original devices in the BFO stages. The most critical device is Q113 for decent BFO injection to the receiver Product Detector, U303. For the transmitter BFO injection, Q114 seemed to be more a factor than Q115 (as you might expect!), and the increased BFO signal made available allows the CW Level Control to be adjusted to a lower setting for good output and smooth control of the PA output level. In fact, the additional BFO output actually seems to make the CW Level Control more broad in its adjustment.

This is probably due to a greater available amount of BFO RF into D143 at lower settings of forward bias from the CW Level Control, rather than when it is almost biased completely off for maximum PA power output when only low BFO drive is present. D143 must have a more linear affect on the output level while it is still partially forward biased versus when it is nearly completely biased off.

The MPF105 used for the BFO oscillator turned out to be more than adequate, and so it was not replaced. After selecting your favorite part for Q113 - Q115, be sure to re-adjust the BFO frequency, and BFO filter inductor L137 as outlined in the manual.

Low VFO output can be corrected with a 2N3906 at Q106, or try several Heath 417-234 transistors (2N3638A) if you have them. My VFO does not exhibit much drift, and other info on tracking down excessive drift is covered in the HW-8 Handbook.

I used a 5.6K resistor across Transmit Return control R131 to make it less touchy to adjust. Just tack it onto the outside leads of the trim pot from the top the the PCB. If 5.6K is too small, try a 6.2K resistor instead. The object is to make the adjusment of the Transmit Return voltage very broad, rather than the difficult adjustment it previously was. Another method would be to use a smaller control than the 50k pot Heath provided, and adjust the ratio of R127 / R131, but the parallel fixed resistor across R131's terminals is easy and neat.

VFO DRIVE PROBLEMS

The small vernier drive used to tune the VFO cap has low torque, and the VFO cap is often mis-aligned with the drive mechanism, causing binding and slippage of the dial. I checked the VFO cap shield for squareness, and it seemed OK. However, the VFO capacitor itself seemed to be non-perpendicular from the rear mounting surface to the shaft. Many HW-9s have one of the VFO shields removed, since this makes the shields more rigid to flexing, with the result being the dial and shaft will bind.

Also, if the vernier is not properly mounted and the hex nuts at *each* end of the vernier tightened properly, there is not enough torque to overcome VFO drive friction. Be sure the vernier nut closest to the small pinion that is part of the VFO vairable cap is snug. If that is satisfactory, tighten *only* the front hex nut on the vernier to secure it to the VFO shield. It is wise to leave the three mounting screws on the rear of the VFO slightly loose and rotate the VFO through its entire range of rotation before final tightening of the vernier drive and the VFO capacitor mounting screws. Find the location of the VFO cap mounting that results in least binding.

If it still binds, either place thin shims between the VFO capacitor and the rear of the VFO shield, or leave the VFO cap mounting screws just slightly loose, but not too loose. Try turning the VFO cap to the point of greatest binding, and then make small movements in the vernier drive and/ or VFO cap mounting screws until it frees up a bit.

I was able to retain the second VFO shield (which I had to fabricate, since it was missing from my HW-9) and find a workable adjustment of the shield and VFO mounting screws. The slide-on second VFO shield is useful in making the knob and tuning shaft "feel" more rigid, as without it, the single "U" - shaped VFO shield is inadequate for overall VFO rigidity. A "box" shape is many times more rigid than a "U" shape, so use both shields if you can without excessive dial slippage. The rotation of the dial should be light and free of binding if you can get it all to work out properly. It is a poor design, and *very* tempermental to assemble.

IMPROVING THE PSA-9 MATCHING POWER SUPPLY

Heath really did a bad job on the power supply for this great little rig. The original design has three series-connected 1N4149 diodes in the ground lead of a LM78L12 three-terminal 100 ma regulator. This is to compensate for the approx. 0.7 volt drop in the current-boosting transistor that is added to increase the output current capacity to 1 amp, and to also boost the output voltage to 12.6 volts or so.

This is bad practice for good voltage regulation, since the added diodes and series current-boost transistor are all outside of the LM78L12 regulator's error amplifier, which in itself is a pretty good device. It's just plain bad design, and whoever at Heath designed this should have known better. Heck, an ordinary LM7812 would be simpler and much better regulated, but I wanted to have the ability to adjust the output voltage and still have good regulation.

Enter the LM317T three-teminal adjustable regulator, (R/S pn.276-1778, $1.99) I stripped all of the parts off of the smaller terminal strip in the original design, and saved the diodes in the bridge rectifier. I decided to use a 4700 uf 35v filter cap instead of the 2500 uf 50v cap Heath provided. The Heath cap is probably adequate, but I had the Radio Shack electrolytic (R/S pn. 272-1022, $3.95) and felt the added filtering couldn't hurt.

Since I like a narrow range of voltage adjustment, I employed a 100 ohm trimpot for the fine voltage adjustment, and used fixed resistors to set the limits of voltage ranget. A 150 ohm 1/4 resistor is used from the output pin of the LM317T to the adjustment pin, and after doing some calculations and a few trial and error tests, I used a parallel combination of a 2.2K and 3.9K resistor between the adjustment pin and the 100 ohm trimpot that connects to ground. The resulting range of adjustment is about 13.1 to 14.1 volts, with 13.6 volts near the trimpot's center setting.

MAKING THE MODS TO THE PSA-9

Mount the 4700 uf 25 v (or re-mount the original 2500 uf 50v cap) electrolytic on top of the larger terminal strip to provide room to work on the new regulator circuit that is built on the small terminal strip. Remove Q1, and the small terminal strip from the power supply. Remove the pilot lamp assembly and save it for later re-installation. Strip all of the parts from the small terminal strip, and save the 100 uf cap for later re-use. The 1N4149 diodes, the 1 ohm 2w resistor, and the 1500 ohm 1/4 resistor can all be discarded or tossed into the junk box. Clean all of the solder, flux, and crud from the small terminal strip using a Solder Sucker or Soder Wick and acetone and prepare it as follows: Cut the terminal strip so that it has only 7 lugs, with 4 on one side of the ground lug and two on the other side of the ground lug. Mount it with the 4 lug side towards the left edge of the power supply chassis as viewed from the front panel. This is flipped from the way it was originally mounted. You may want to pre-mount most of the following parts to the terminal strip temporarily mounted on the outside bottom of the chassis for convenient access to the lugs.

If you have another value for the trimpot, you'll need to experiment with the fixed resistors between it and the adjustment pin to get the 13.6 volts or so I think is ideal for the HW-9. Use another pot of 3K to 5K in place of the fixed resistor for a coarse control and use the small value trim pot you'll keep for the fine adjustment. Set the range with the 3K or 5K pot with the 100 ohm to 500 ohm fine adjust pot in its center setting. Then, measure the value of the 3K to 5K pot with an ohm meter and select a fixed resistor or combination of fixed resistors to match the measured pot value.

I soldered some 16 gauge wires to the LM317T 3-terminal regulator and covered the connections with insulating tubing. It is mounted in the same hole as Q1, (Heath pn 417-852, TIP31) the pass transistor was bolted, using the same insulating mica washer and nylon shoulder washer. I soldered the input pin of the LM317T to the positive terminal of the 4700uf 35v (or 2500uf 50v cap if you keep the Heath part), and connected the adjustment and output leads of the LM317T to the first and second lugs of the small terminal strip, as viewed from the front of the power supply, left-to-right. The 150 ohm resistor is connected from lug 1 to lug 2, and one end of each of the parallel combination of the 2.2k / 3.9K resistors are also soldered to lug 1, with the other ends soldered to lug 4.

The 100 ohm trimpot (a CTS blue knob miniature trimpot, like the ones Heath uses in the HW-9) is soldered facing up across lugs 4 and 6, with the center (wiper) lead in the bottom hole of lug 5. Bend the outer terminals of the pot so they are flat against the terminal lugs, and at a right angle.

I re-used the 100 uf electrolytic cap C2 from the old circuit for transient load suppression. The negative lead connects from lug 7 to lugs 6 and 5 (ground). The positive lead goes to lug 2 and 3 (output). Also run a wire from the bottom hole of lug 2, which is the output, to the fuse mounted on the back of the case. The pilot lamp is retained and connected to lugs 2 (output) and 7 (ground).

I heavily painted the terminals of the AC power slide switch with some red fingernail polish, so I would be less likely to touch 110v when adjusting the trimpot to the desired output voltage. You could also use some insulating sleeving if you re-dress the wires on the switch lugs slightly.

I noticed some voltage drop across the original 1 1/2 amp output fuse that reduces the loaded voltage regulation. I replaced it with a 2 amp fuse that had less series resistance and caused less voltage drop under load. A better solution would be to move the fuse to the unregulated side of the LM317T chip, between the filter cap and the input terminal. This would eliminate all fuse-induced voltage drop, and still provide the desired protection from short circuits across the output, and would also protect the LM317T and rectifiers better.

The new regulated supply is adjustable from about 13.1 volts to 14.1 volts, with 13.6 volts near the center of adjustment. Output current is more than 1 amp, typically 1.5 amps, and the ripple is below 1mv on my DVM under a load of 1.5 amps using a 8 ohm load resistor. The output voltage as measured between the power supply chassis and the input to the fuse does not measurably change from no load to 1.5 amperes. The only measureable voltage drop is in the wiring and connections to the HW-9, and this is only approx. 0.2 volt during transmit. The HW-9 now has a very stable power supply that is ripple-free and well regulated, further reducing the chance of any frequency shift of the BFO, or HFO, since they are supplied from the 12 volt (13.6 volt actual) PSA-9 DC supply.

REMOVING THE VFO CAP AND RESTORING THE POTS

I find it easier to remove the screws

securing the back panel and middle shield to the sides of the chassis to permit room to remove the VFO capacitor. Leave the middle back panel screws alone, and spread the sides slightly to allow both the T/R and Oscillator boards along with the middle shield to slip back an inch or so. Then the VFO cap will come out easily if you have removed the tuning shaft extension and the four 4-40 nuts from inside the VFO shield.

If the pots for some or all of the front panel controls have gotten dirty or have a poor feel, you can unsolder the wiring and remove them to be cleaned. By prying up the tabs that hold the back of the pots together, the resistance element and shaft can be removed. Clean the wiping contacts and the resistance elements with Q-tips or a toothbrush and Soft-Scrub (tm). Rinse everything well under water and dry. I use silicon grease on the shaft and shaft bushing to get that nice "feel" when rotating the pot. The RIT pot needs to have a little grease on its back cover to allow the center detent to act properly. Replace the pot cover and gently squeeze the tabs back in place with some large needle-nose pliers. This may save you some money on new pots, and will generally restore the pot's function to new condition.

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Check your junkbox to see if you have a 33pf or 36 pf N150 to N220 disc cap. Replace C184 with this value. I used a 36pf N220 in mine and the VFO freq. drift has decreased to only 400 hz (downward in freq.) in the first thirty minutes, stabilizing within a few hz after 30 minutes. Try another N-value if you don't get good results with this recommendation.

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Compensating C184 inside the VFO inductor shield is not a cure-all, but it helped a lot with my rig. I would recommend not adding dial or meter lamps to the rig, since that would present a large source of heat that would adversely affect the temperature stability.

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If you listen to the transmitted signal of the HW-9 on another receiver while you vary the rig's output with the CW level control, you will detect a big change in the transmitted frequency. Not only that, the RIT control that is supposed to be deactivated during transmit has a considerable effect on the transmitted frequency! Because of this, your TX offset that is supposed to be determined *only* by the BFO being pulled 700 hz lower in frequency won't be correct at all. And this problem varies from band-to-band with different power levels. What a pain this is!

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Note that the TX Return adjustment with trimmer R131 is stable now, and it does not change the voltage at the measurement end of R127 when you set it with

your DVM and vary the CW Level control. Put a 5.6K or 6.2K resistor across R131 if you want it to be less critical to adjust.

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SUMMARY

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RELATIVE POWER METER MODS

With the earlier mods I made to the transmitter stages, increased BFO injection, and the increased VFO from the HW-9 mod article in QEX / QRP Power, I have more than enough transmitter output on all bands. In fact, on 80m - 12m the output is enough to pin the relative power meter easily and that makes it hard to reduce the CW level to the 5 watt level based on the relative power reading without using some care. So I made a few changes in the relative power sensor that feeds the meter.

Since Heath only spec'd the rig for 3

- 4 watts output, a few minor changes are necessary after increasing the the output to ~ 5 watts. I replaced a10k resistor , R431 with a 12k resistor. This reduces the voltage to the meter circuit and makes the meter sensitivity more in line with the true maximum output of the rig, which on mine is as great as 9 watts on the lower bands. To keep the meter from pinning and slamming against the full scale limits, I placed a IN4242 12 volt zener diode (R/S pn. 276-563, 2 for $0.99) from the cathode of D408 to ground. A smaller wattage zener diode would be fine, I just had the 1 watt unit in the junk box.

There wasn't a good point on the top of the PCB to place this diode, so I put it on the underside of the PCB. This zener limits the relative power sensor to an output of 12 volts and sets the meter's maximum range to the 60db over S9 limit. 5 watts shows up at about 40db over S9 on all bands now, and I find it much easier to judge the power output from the meter reading even if I don't switch the WM-1 on. The scale seems to be more meaningful with the maximum reading limited by the zener, and the needle is no longer slamming against the pin as it did before. Try it - you'll like it.

Note that you should do the mod mentioned in the QEX article to the Mute line of U301 to prevent the transmitted signal from affecting the AGC/S-meter readings caused by the IF amplifier "hearing" the output signal. This can cause misleading relative power measurements. It's very easy to do this mod.

ACTIVE AUDIO FILTER MODS

The active audio filter was peaking at about 950 hz, while the IF f_C (center frequency) is about 550 hz. So I took a look at the filter's components. Heath used .001 uf ceramic discs (C339, C341, C344, C345) for the filter, which have a tolerance of 20%. All of the caps in mine were low in value, in the 850 - 980 pf range. I found some nice polyester caps (the slim green kind) and matched four with my AADE L/C meter at almost exactly 1000 pf (.001uf) to replace the ceramic discs.

The f_C is now at 710 hz, at least more in line with what was intended. A possibly better value might be .0012 uf if you can find some, or get them from Digikey as I plan to do. The polyester caps are much more stable and can be found with as good as 2% tolerances. The higher capacitance should bring the f_C down to around 600 - 650 hz to more closely match the f_C of the IF filter. I'm going to try and adjust the BFO frequency slightly to see if I can get the IF and AF f_C to be more closely matched.

All of my other rigs use green polyester caps in the AF filters, and they perform as designed. While you're at it, you might want to replace C338 on U304B, the low-pass fitler. I have found that many of the glass axial monolythics Heath used in the HW-9 are waaaaay off value, and a good .01 uf cap for C338 should bring the filter's low-pass characteristics back in line. Some of the glass caps were as much as 0.194 uf in value! Use a .01 uf polyester cap instead of the glass axial unit.

While you're at it, check the associated resistors in the low-pass and band-pass filters to be sure they are all within a few percent of the schematic value. For some reason, Heath used very high value resistors in these filter networks, and that just contributes to more noise. My other rigs' audio filters use caps that are a decade larger, i.e. .012 uf, so the resistors are much smaller and the developed noise is less. The QEX article reprinted in QRP Power used a completely different set of RC values for the active filter, but some of the values may be hard to find. If you can find the parts in that article, it may be a better design. I just used what I had, and will probably try to collect the parts in the article to try at a later date. The improvement I found in the filter's behavior was good, but it's still not the equal of the Tac-

1 and ARK30 filters.

SOLUTIONS TO LOW POWER OUTPUT

While corresponding with another member, I have found some areas to check if your transmitted output is low. First, be sure one of the final PA's is not blown. Get some larger heat sinks for Q405 & Q406. I used NTE401's. They just fit under the plastic band switch, and you can move one of the old heat sinks to Q404. This is necessary if you want to preserve the MRF237's at power levels near 5 watts. They are pretty tough, but the larger heat sinks are welcome insurance to your peace of mind.

Be sure diode D407 isn't shunting RF output from the PA's output. While transmitting on 80m into a dummy load at full output, it should *not* get warm. If it does, change it out with another 1N4149 and check C443. If C443 is much over .01 uf, it should be replaced with a smaller value. It is probably OK to use .005 uf or even .001 uf, but the sensitivity might suffer a little on the lower bands. I found I didn't have to use less than a .01 uf if I used a good 1N4149 diode at D407. Insure the bias network for the diode switch is working OK, and check the components for failure or out-of-spec values.

Forget trying hot-carrier diodes or small PIN diodes for D407 without completely redesigning the bias network Heath uses, as they will quickly fail without the proper bias currents. The IN4149's have greater breakdown voltage ratings, and are more rugged than the PIN or hot-carrier types without the required bias changes. The QEX has complete details on using PIN diodes, but it's a difficult mod to do and the space is very limited around the T/R switch area. The Heath design will work OK, but some work is necessary to find and use decent components. Increasing the RF output to 5 watts or more exposes the shortcomings of Heath's design. A pair of back to back diodes would probably be a *much* better idea.

If anyone has done the QEX article mod to the PA stage that "flattens out" the gain-vs-frequency characteristics. I would like to know how it worked, and what you thought. E-mail me direct. I'm still contemplating that mod, and may try it if the results were good. The rig needs some form of "ALC" to control the maximum power output on the lower bands. I'm looking at a way to use the relative power output to accomplish this, but the QEX mod might be the better way to go.

SIDETONE THOUGHTS

I am disappointed with the poor sidetone waveform, so I leave it turned off. If you feel the same way about the sidetone, but reducing the sidetone adjustment to minimum doesn't completely eliminate it, change R367 from 150k to 220k. This should do the trick. If anyone has ever seen a decent circuit to make a sidetone oscillator using op-amps, I would like to know about it. All of them I have seen produce lousy waveforms. Why everyone doesn't just use the "twin-T" oscillator is beyond me. I simply can't stand anything but a clean sine wave sidetone, so I usually use another receiver for monitoring my signal. Perhaps a RC phase shift network is the solution, but the "twin-T" is simpler and produces a sine wave with a single transistor! Oh well.

SUMMARY

If you try some or all of these mods, please let me know how well they did or didn't work for you. I welcome your comments or observations. Note that Heath made several errors on the schematic, and that all of the active audio filter ceramic disc caps should be identified as 1000 pf (.001 uf), even though C339 and C341 are shown as 100 pf. Also, R354 is shown as 15 megohms, when it is really 1.5 megohms as R359 is. I am still trying to find out what device Q403 is, as the manual fails to mention it in the Semiconductor

Identification Chart. It is only identified as a Heath part number 417-865, for which I have no information. There are surely more errors and omissions in the manual and schematic if you look for them.

Thanks for the interest in improving the HW-9, and try these ideas if you get a chance. I think you will like the results. For more info on improving the crystal IF filter, see the ARRL's Hints and Kinks for the Radio Amateur, 13th edition, pages 1-4 and 1-5. I have the Kenwood IF filters to do this mod, but I think I'll use the radio as-is for a while before getting out the soldering iron again.

SUMMARY

Much credit also goes to the contributors of the HW-8 handbook, and other articles found in QST, QEX, etc. Those sources are a good place to look if you want additional information on improving your HW-9. 72, AB7MY, Gary Surrency, AZ ScQRPions

References:

QEX, October 1990, pgs. 3-9
Reprinted in: QRP Power, copyright 1996 by the ARRL, pages 3-26 to 3-32

G-QRP Club Rochdale Convention Reports

by Dick Pascoe, G0BPS
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The annual pilgrimage to Rochdale in the north of England for the QRP convention took place over the weekend of 25th October 1997. What a change though, I had just returned from Cyprus on the family holiday with temperatures in the high 20's and the low temperatures of the moors brought out an awful cold. Oh well.

The Church hall of St Aidan's is roughly the same size as many of the halls attached to Churches throughout the UK. Able to take up to 400 people at any one time they feel very packed if numbers get above that, The hall is attached to the Church and only about 200 yards from the home of the vicar, George G3RJV.

Those visitors who braved the cold had a great day out with the outside low temperatures soon vanishing as many warm bodies in an enclosed space soon made the jumpers vanish.

The G-QRP club stand manned by John G0BXO, Graham G3MFJ, Peter G3PDL and others did a roaring trade as usual, Gus G8PG spent many happy hours answering members questions on antenna problems. The Bring and Buy run by the local radio club went smoothly once they realised that seven members in a small space resulted in no punters being able to see the goods for sale.

Next to the B&B was the largest stand of all, Chris from the famous 'sheds' who sells huge amounts of valuable surplus equipment. Some may call it junk, but one mans junk is another mans delight. (Until the wife sees it of course.)

The main hall is always set out with traders around the outer edge and the middle of the hall set out with tables and chairs for visitors to chew the cud and explain the intrinsic parts of their latest project. Lunch is also consumed by many here. The traditional lunch of meat pie, mushy peas and red pickled cabbage always goes down well. A great pity that our usual supplier had died. The supplier used this year was the local hospital! It tasted good but the lingering thought was of course, what meat was in it?

The traders there included, Hands Electronics, JAB Components, Essex lads, Kanga Products, Practical Wireless magazine, The QRP Component Company and a few members disposing of their junk.. sorry ... quality used equipment.

This year the number of visitors increased to a massive 375 which blew away the old record of 320. This sounds on the face of it as good news but when you think

of the numbers this hall can take, with those helping we just about reached capacity, this amount of people can only cause problems. We again talked of moving the event, and again came to the same conclusion that we should not.

It is usual to have a series of talks in the church during the day, this year saw George G3RJV kick off with a tribute to the late Doug DeMaw W1FB. Doug will be sorely missed by all that knew him.

The next talk was from Dick G0BPS on home construction techniques to a packed church. Covering everything from Veroboard to PCB's via blob boards and island cutting. Fitting of components, even soldering hints.

Following this was Rob G3XFD with his usual session on matters of interested to all amateurs and finally the guru himself, David GM3ZNX. David is one of those (enviable?) people who have total recall. Ask him a question on almost any subject and he will give you the (correct) answer at any level you may require. He always comes down to the lowest common denominator so that everyone can understand. In all the years I have known David I have never known him stumped by a question. His sessions are always the last as we have to drag him out of the church to lock up and go home!

Visitors this year included the usual Dutch contingent with the addition of another old friend Edwin PB0AOL on his first visit. No visitors from the USA this time but a first timer from Spain. Known by his comments on the gqrp-l email list Jon Iza EA2SN thoroughly enjoyed himself, so much so that he presented several of us with a small Morse key made in Spain as a momento and thank you.

The usual bunch from Germany made it over again with their wives, albeit for a short trip. One couple were off to the far east for some shopping they said. Johnny and Birgita Apell from Sweden brought their usual range of salmon and herrings over, no need to ask who pigged out on all this wonderful fish.

The selection of date this year was also a good thing for several members who were teachers. They were able to stay over rather than dash up on Saturday morning and leave on Sunday to dash back. Next year it is intended, but not yet confirmed that the convention will be on Saturday 24th October. A special note for your diary is required.

The end result was a great day out for all those who made the effort.

It may seem a small event by many other standards such as the 4DIM at Dayton, but ask anyone who has been from the USA and I wager they will say it is well worth the trip. Accommodation is fairly cheap at about $50 per night for bed & breakfast for two and a good hotel is only 300 yards from the hall. Air fares vary according from the start point in the US. A very good welcome will be given to any readers that may decide to come over for what is, without doubt the biggest and very best QRP event in Europe. For more information email me at: gqrp@kanga.demon.co.uk TTFN de Dick Pascoe G0BPS

by Tony Fishpool, G4WIF
g4wif@btinternet.com

The very best G-QRP event of the year, just has to be the October annual convention at Rochdale in Lancashire, the home of George G3RJV. It is held in the church hall and takes the form of an informal gathering, rather than the "run of the mill" radio rally.

Having arrived at the home of Graham G3MFJ the day before, we travelled from his home in Leeds to Rochdale via the high Pennine road which is often impassable during the winter. The road takes you through some of the bleakest, and yet quite majestic moor land that separates Lancashire and Yorkshire. This is not somewhere you want to break down. Also

in the car was Steve G0TDJ and his wife Jo G0UAO.

With plenty of time to spare, we passed an already long queue to set out our various stalls in the hall. Then the doors opened and suddenly it got crowded. Unlike other gatherings, the emphasis is on meeting other members and comparing homebrew projects and ideas, and toward this end, the centre of the hall is taken up with tables and chairs, so we can really get down to some serious chatting.

Around the hall were the stands of many traders that support the QRP community, Kanga, Hands Electronics, JAB and the QRP Component Company (Chris G3TUX). Of course there was a "bring & buy" stall.

As usual, we had some excellent speakers. Dick Pascoe spoke on Construction Techniques and Dave Stockton shared his extensive knowledge on all things electronic. We were also honoured by the presence of Rob Mannion, the editor of Practical Wireless, Britain's leading radio magazine. Rob spoke of upcoming changes to PW and also canvassed opinion about what we would like to read about. It is quite something that Rob should take time to seek feedback in this way and at no small inconvenience to himself, and is why he is the respected figure that he is, a fine ambassador for the hobby.

There was also plenty of good food to be had, and thanks are due to the unsung heroes in the kitchen, among them Jo Dobbs (G0OWH), Margaret Keyser 2E1DFH and Daphney Pascoe. If I missed anyone else, please forgive my failing memory.

Later as the convention "proper" came to an end, and after we tidied up, came the best bit. This is where the "hard core QRPers" make their way up to the vicarage. The subject of discussion of course was QRP (what else?). As I passed through the hallway on the way to the bar (kitchen), I heard conversations in various languages, such is the cosmopolitan nature of the event. QRPers filled every room and I saw folk drawing circuit diagrams on just about anything they could find. As we started to get hungry, a Chinese "take out" arrived for about 120 and we paused just long enough to refuel and then get back to the talking. Later, just about midnight, I was present at a fascinating discussion between Ian Keyser (G3ROO) & Dave Stockton (GM4ZNX) about the relative points in front-end design. Each had a differing opinion of how to achieve and measure performance, and as we sat round listening to the light hearted debate, I couldn't help wondering if there shouldn't be some way of scoring as they batted technological terms back and forward. I must admit that although I understood every word they said, it was the sentences I had trouble with. They were way over my head, but it was fun just the same.

The evening drew to an end at some time in the "wee" hours, and Graham (G3MFJ), Jon (EA2SN) and I, crossed the road to the new (and very nice) Royal Toby hotel. Contrary to common practice in the U.K., they charge by the room, so it works out very economical. The next morning, after the traditional (artery clogging) English breakfast, we dropped into the vicarage. Quite a few people were there, still chatting (about radio of course), as though they hadn't been to bed. We said our goodbyes and made our way home having enjoyed one of the best weekends of the year. 72, Tony - G4WIF

Use SPICE to Design Your 2N2222 Receiver

by Glen Leinweber, AE0Q
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There's many possible threads to the 2N2222 40M building project: audio amplifiers, receiving or transmitting mixers, RF class C power amps, T/R switching etc. I'd like to tackle one small part:

How to use a buncha 2N2222's to make a receiving mixer After dealing with the mixer, we'll add an audio preamp, a VFO, and end up with a 40M direct conversion receiver. You'll be able to plug its output into one channel of a stereo, and fill the room with 40M CW and SSB.

The whole receiver will use 5 or 6 2N2222's, and we'll need some resistors, and capacitors, and a few T50-2 toroids. You'll have to scrounge some variable capacitors too, so that the VFO can be tuned and so we can select the 40M band over all the others coming in.

If you really want to investigate the innards of the mixer, let me suggest that you beg, borrow or download a copy of PSPICE. You'll be able to examine all the currents, and voltages in detail, and play about with component values to see what happens. Even if you have a scope, SPICE will still let you see more. Its a great learning tool. And a slightly hobbled version is free - downloadable from MicroSim Corp. I'll be using PSPICE to illustrate circuit function.

On to the MIXER

We're going to tackle what's known as a "singly-balanced mixer". It isn't the simplest type (you can use a single diode if you want) but it has decent performance. And once you understand how it works, you're well on your way to a Gilbert-Cell mixer (double-balanced), used in NE602's and MC1496's. Here's the basic circuit. [See Fig. 1]

The 7Mhz R.F. signal coming in from the antenna goes into the base of Q1 and Q2. The local oscillator (L.O.) from the VFO goes into the base of Q3. The output of the mixer comes out of the collectors of Q1 and/or Q2.

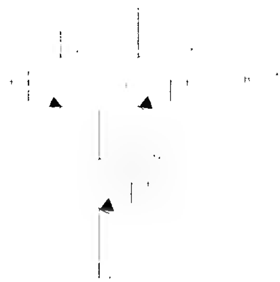


Fig. 1

Local Oscillator input:

We want the local oscillator signal to change Q3's collector current up and down at a 7 Mhz rate. We'd like the current to change from almost 0 ma. to a peak of about 4 ma. Why this level? Its a compromise - more current would give us a "stronger" mixer, able to withstand larger interfering signals before causing dreaded IMD (intermodulation distortion). But we'd like to use less current for small signal low-noise work.

Now if everythings well balanced, Q3's collector current splits evenly between Q1 and Q2; that is, as long as there's no R.F. at the bases of Q1 and Q2. Half the current will flow up thru Q1, and out its collector, and the other half up through Q2.

This circuit gets interesting when there's some R.F. signal applied between Q1 and Q2's bases. Let's say we've got a QRO signal at 7.001Mhz coming in across these bases.

The R.F. signal changes the current balance sharing between Q1 and Q2. Let's pick a moment in time when the R.F signal coming into Q1's base is in phase with the 7.000Mhz current supplied by Q3. Q1 will attract more of Q3's current, and Q2

will get less. But 3500 cycles later (0.5milliseconds) the situation will have reversed, with Q2 hogging more current, and Q1 getting less. This is because the local oscillator frequency and R.F. frequency differ by 1000 Hz. So what we'll see at Q1's collector is a 7Mhz current, that is modulating up and down at a 1000 Hz rate. The amplitude of this modulation depends on the amplitude of the 7.001Mhz R.F. signal. This is the desired difference frequency that we want from our direct-conversion receiver. A simple low-pass filter will attenuate away the 7 Mhz. signal, and leave the 1Khz remainder.

We could take the output from either collector. It would be best to take the output BETWEEN the two collectors, since while Q1's1Khz signal is going up, Q2's is going down. Indeed, many circuits use a center-tapped audio transformer here. Why don't we do that? Because they're available from so few sources, they're expensive now, they're heavy and bulky, and prone to magnetic hum pickup. A less desirable, but much simpler approach is to ignore one collector, and use a resistor on the other collector to give us an output voltage.

Now there's enough background to try a PSPICE circuit. Let's keep it dead simple for now, and avoid biasing these transistors. PSPICE lets us specify a D.C. voltage on each signal source, so we'll use that facility to bias the transistors as described

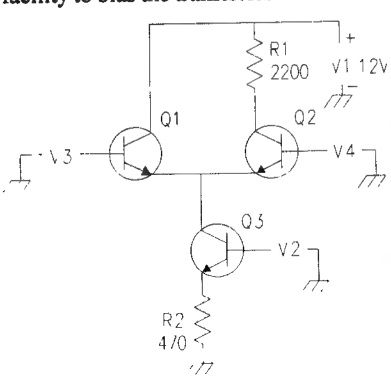


Fig. 2

previously.

Remember, we want average current through Q3 to be 2.0 ma (4ma peak). Emitter voltage on Q3 will be .002 * 470 = 0.94v. Q3's base-to-emitter voltage will be about 0.62v, so its base should sit at .62+.94 = 1.56v. We'll set it at 1.6v D.C.

The peak A.C. amplitude going into Q3's base is determined by how low it can go before Q3 turns off (collector current goes to zero). With zero current, Q3's emitter will be zero volts, and its base-to-emitter voltage will be about 0.6v. So V2's peak voltage could be set to 1v peak. To summarize: V2 has 1.6v D.C. and 1v peak A.C.

Let's turn to V3 and V4. Their D.C. voltage will be identical in order to maintain balance. We have some latitude in choosing this voltage, but lets see how low it could go:

Q3's collector must be higher in voltage than its base if its to work linearly. Maximum base voltage will be the D.C. voltage plus the +ve peak voltage: 1.6 +1 or 2.6 volts. Q1 & Q2's base will be about 0.61v higher, or 3.21v. Let's set V3 and V4 to 3.5v D.C. to be safe.

With R1 at 2200 ohms, and maximum collector current of 4 ma., Q2's collector will drop (2.2 * 4) volts below the 12v power line. That's really a bit too much - it means that if the R.F. input signal is big enough, Q2 can saturate on a peak. But such a strong signal is quite unlikely, and the filter capacitor we'll add there later will keep Q2's collector from voltage saturation anyway.

We'll set the R.F. input voltage to 10mV peak. This may seem small, but Q1 and Q2 have quite a bit of gain, and you'll see a fairly big mixer output at Q2's collector.

Instead of starting off with our 7Mhz example, we'll look at some lower frequencies instead. Why? So that all the signals will appear close to ideal. Transistor capacitances and transit times won't bother us this way. So V3,V4 will be at 100 Khz,

V2 will be at 103 Khz. We want V3's voltage to be going +ve when V4's voltage is going negative - this is a balanced input remember. SPICE will accept signed amplitudes for these voltages, so we'll make one +ve and the other -ve.

Here's the PSPICE file ready for simulating and probing:

```
*2N2222 singly-balanced mixer circuit
.TRAN 10us 1ms
.PROBE
V1    1 0    DC 12V
V2    2 0    DC 1.6v
+          SIN(1.6v 1v 100KHz 0 0 0)
*+          PULSE(0.6v 2.6v 0s 30ns 30ns 5us 10us)
V3    3 0    DC 3.5v
         + SIN(3.5v .01v 103KHz 0 0 0)
V4    4 0    DC 3.5v
+          SIN(3.5v -.01v 103KHz 0 0 0)
Q1    1 3 5   Q2N2222
Q2    6 4 5   Q2N2222
Q3    5 2 7   Q2N2222
R1    1 6    2200
*C1    6 0    0.02UF
R2    7 0    470
.model Q2N2222  NPN(Is=14.34f Xti=3 Eg=1.11 Vaf=74.03 Bf=255.9 Ne=1.307
+          Ise=14.34f Ikf=.2847 Xtb=1.5 Br=6.092 Nc=2 Isc=0 Ikr=0 Rc=1
+          Cjc=7.306p Mjc=.3416 Vjc=.75 Fc=.5 Cje=22.01p Mje=.377 Vje=.75
+          Tr=46.91n Tf=411.1p Itf=.6 Vtf=1.7 Xtf=3 Rb=10)
*          National     pid=19      case=TO18
*          88-09-07 bam    creation
.END
*
```

This SPICE file will show voltages and currents as a function of time, the way you'd see them on an oscilloscope. Total time is 1 ms., which should show three cycles of the 3 Khz mixer output, and 100 cycles of the local oscillator waveform.

Take a look (by running "probe.exe" at collector current for Q3...IC(Q3) It should be a sinewave, going almost to zero, and up close to 4 ma.

Take a look at Q1 and Q2 collector currents ...IC(Q1) ....IC(Q2) Collector currents of Q1 and Q2 should be similar in some ways, swinging from close to zero up to 2ma. You should see some 3 Khz modulation of the 100 Khz. waveform. The 3 Khz. currents in Q1 and Q2 will be out of phase: one will reach a maximum when the other is a minimum.

Look at Q2's collector voltage ....V(6,0). This is the mixer's output. You'll see that it contains both 3Khz and 100Khz components. We're only interested in the difference frequency (3Khz). How do we separate it from the rest? With a low pass filter. If you add a capacitor from Q3's collector to ground, the higher frequencies will be attenuated. It'll be much easier to do when we're trying to separate 1Khz from 7 Mhz. You could add a capacitor to the PSPICE file with:

C1 6 0 0.02uf

In the example above, the mixer is operating in a linear fashion - sinewaves everywhere. Often, these mixers are run in a "switching" mode, where Q3's collector current switches on and off in a squarewave fashion. You could try this out by changing V2 to a squarewave source. Replace the line that determines V2's characteristics with:

\+ PULSE(.6v 2.6v 0s 30ns 30ns 5us 10us)

Now there's a potential problem that we might address now. If we had used a balanced output from Q1, Q2 collector with a center-tapped transformer, any variation in the 12 volt supply voltage would not bother us. But since we're taking the output single-ended, we must be careful of any hum or noise on the supply - remember we're still dealing with very low-level signals here.

So let's add a simple active supply filter to ensure that we have no A.C. stuff (especially hum). This will require another 2N2222, and a resistor/capacitor filter. The RC lowpass filter should reject 60 Hz to a low level. A large R*C product is required. An electrolytic capacitor of 100uf/16v is fairly small physically - let's see what resistor would give 60dB attenuation (1/1000) at 60Hz:

R = 1000/(2*PI*F*C) = 1000/(6.28*60*100e-6) = 26525 ohms

Our mixer would have to draw all its supply current through this resistor. That's no good because 2ma. through 26525 ohms is much more than 12v! But with a 2N2222 emitter follower, 2ma of emitter current translates to 2/150 ma. base current, assuming HFE of 150. Now we only have about .35v drop across the 26525 ohm resistor - we could make it even bigger!

Here's the circuit:

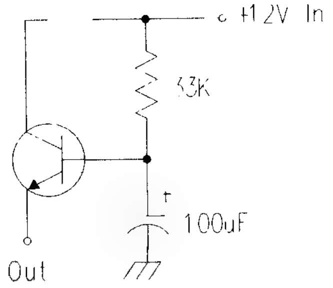


Fig. 3

The smooth output voltage will be lower than 12v by .62v (base-to-emitter voltage) plus the .35v drop across the 33k resistor. So now we have a very clean supply voltage of about 11v for the mixer.

D.C. Biasing

We've cheated by getting all the voltage sources (V2, V3, V4) to supply all the D.C. bias voltages - not possible in a real circuit. So lets figure out some resistor voltage dividers to give about the same biasing as discussed previously:

Q4 base: 1.6v

Q1, Q2 base: 3.5v

These two voltages can be had with a three resistor voltage divider between +11v and gnd. These resistors should be small enough that the 2N2222 bias currents don't cause significant error. On the other hand, they should be large so as not to load our sources. Q4's average collector current is 2ma. The 2N2222 current gain is in excess of 150, so base current is 2/150 ma. If the current in our bias resistors is about 20 times Q4's base current, things will be stable. So the total resistance will be 11/(2*20/150) kilohms...41.25K.

The bottom resistor should have 1.6v:

1.6/(2*20/150) = 6K

The next resistor should have 3.5v-1.6v:

(3.5-1.6)/(2*20/150) = 7.125K

The top resistor should have 11v-3.5v:

(11-3.5)/(2*20/150) = 28.125K

We must use standard values - choose the

next lower available:
>From 6k to 5.6k
>From 7.125k to 6.8k
>From 28.125k to 27K
Because there's base current for Q1, Q2, and Q4 flowing thru the 27k resistor, let's go to the next smallest value of 22K instead.

Add an Audio Preamp

We're going to drive a stereo with the mixer output...the signal here is still pretty small. Even with the volume turned up all the way, audio level will be very low. A simple audio amplifier is needed after the mixer. The audio output from mixer's Q2 collector will be coupled into the audio amplifier with a capacitor. Here's about the simplest circuit for a low-level audio amp:

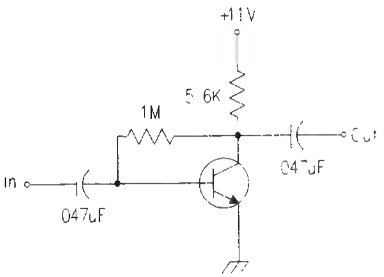


Fig. 4

This amp is biased for about 0.5ma collector current. Why choose this value? It'd work OK with anything from about .05ma to 10ma. We want the collector voltage to be about half the supply voltage, so it can swing equally well up and down. This defines the collector resistor:
.5ma through 11/2 volts = 5.5K

Most stereo AUX inputs will accept this driving impedance OK. The base bias resistor is a little tricky to select, because its value depends on the transistors' current gain. Since it too will have about half supply voltage drop, its value should be HFE * 5.5K = 825K. We'll use a 1MEG resistor.

The input coupling capacitor must pass 1Khz audio. It's minimum value is dependent on the associated resistances: the mixer's load resistor + the audio amp's input resistance. This is rougly equal to hie. From the Motorola Data book, (@ .5ma Ic) hie is about 5 Kohm. The actual amplifier input impedance is a little lower, because of negative feedback through the 1MEG base bias resistor.
So C=1/(2*PI*1000*(2200+5000)) = .022uf
You could use anything larger - with 0.047uf, audio response should go down to about 500 Hz. A 0.1uf would allow good SSB reception (250Hz).

If you've got a particularly hot 2N2222 here, then collector voltage will be low - a lower gain 2N2222 will give collector voltage closer to the supply voltage.

R.F. Input Circuit

Now let's work on the antenna end. We'll assume an antenna input of 50 ohm impedance. We'd like to know the mixer's input impedance too. Let's also specify that the mixer should be driven in a balanced way.

A balanced circuit will give symmetry between Q1 and Q2 bases. Otherwise our mixer will be susceptible to A.M. interference. Why? Let's suppose that we send the R.F. input into Q1 base, with Q2 base simply biased at a constant 3.5v D.C. This is an unbalanced input. Q1's base to emitter junction is really a diode. Its non-linear behaviour will act as a rectifying diode for strong A.M. signals. The result is an audio signal at the mixer's output. Not good.

With symmetry maintained, the non-linear behaviour of Q1 will be cancelled by an equal, but opposite non-linear response from Q2. Thus, A.M. interference at the mixer output is smaller.

Balance is so desireable in a mixer that the local oscillator port is often made

to be balanced as well. The result is a very common doubly-balanced mixer of the Gilbert-cell variety (NE602, MC1496). It requires at least six transistors, all carefully matched, so you'll mostly see it inside integrated circuits instead of discrete circuits.

Our antenna coupling/matching circuit should have some selectivity, so that 7Mhz signals are efficiently coupled, while all other frequencies are attenuated - this is a job for a resonate L and C circuit. This circuit can also match our 50 ohm antenna up to the higher impedance of Q1 and Q2. Let's estimate the transistor input impedance. The Motorola data sheet says that at 1ma. collector current, the hie (input impedance) should be about 4k. However, this was measured at 1Khz, not 7 Mhz. Input impedance will be significantly lower at 7Mhz. A rough guess would be 1000 ohms. Since our input is between Q1 and Q2 bases, the input impedance is twice that of one device, or 2000 ohms.

If we use a transformer type coupling between antenna and base its turns ratio should be SQRT(2000/50) or about 1:6. Let's try and see if we can make the base side of the transformer a tuned circuit:

We'd like the selectivity of this tuned circuit to be quite narrow so that only the desired 7Mhz. signals get in. Let's see if we come up with reasonable values for L and C if we make the bandwidth cover the whole band: 300 Khz. Loaded Q would be 7/.3 or 23. So the inductive reactance of the coil should be about 2000/23 ohms. This would require L = (2000/23)/(2*PI*7e6) = 1.977uH The resonating C value would be 1/(4*PI*PI*(7e6)^2*L) = 260pF This looks reasonable: we could make it even more selective and still have reasonable values. Since loaded Q is much less than unloaded Q (about 250 for tuned toroids), losses will be low.

We should make this circuit tunable,

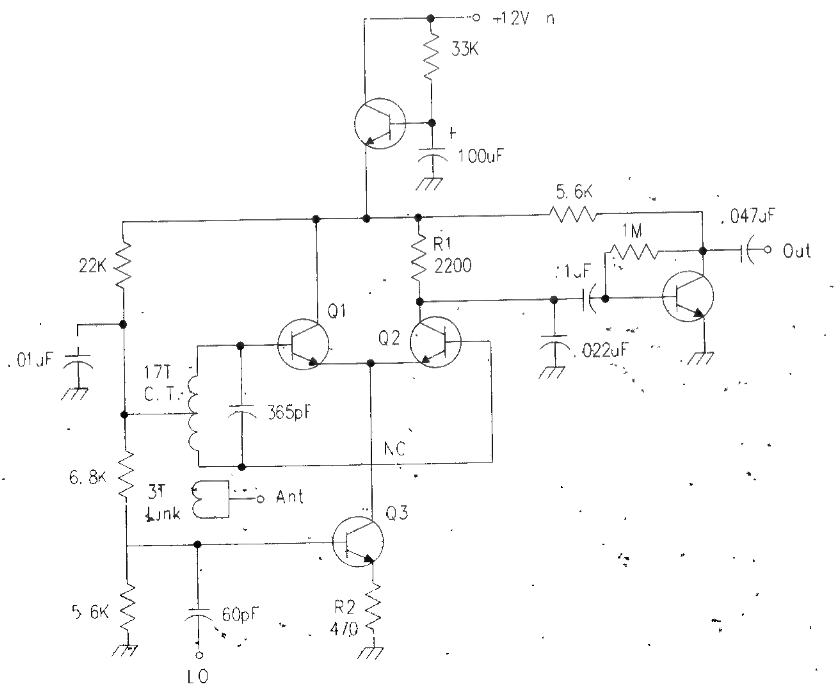


Fig. 5

since Q1 and Q2 will have some capacitance of their own, and inductance will vary from one coil to the next.

Let's find the number of turns required on a T50-2 iron-powder toroid to give between 1 and 2 uH:

>From the data sheet for T50-2 toroid: 49 uH per 100 turns

N = 100*SQRT(1/49) = 15 turns for 1uH

N = 100*SQRT(2/49) = 20 turns for 2uH

Let's choose a 17 turn resonating coil, with a three turn link for the antenna.

17 turns gives an inductance of (17/100)^2 * 49 = 1.416uH Resonating capacitor is 365pF.

Depending on what trimmer capacitors you have available, you can decide what portion of this 365 pf should be a fixed capacitor, and what portion would be part of a trimmer. Keep in mind that this trimmer has neither lead grounded, so a panel-mount trimmer is not an option. One possibility is a 330pf fixed capacitor, and a 60pf trimmer. See Fig. 5.

The Local Oscillator (VFO)

All the signal path has been addressed, but we still need to inject a 1 volt peak signal of 7Mhz into the mixer. We have a variety of good oscillator circuits to choose from: Hartley, Colpitts and their variations. We could use one of Doug's 7.040 Mhz crystals as the resonating element, but a VFO implies a resonant LC oscillator. We'll do a T50-2 toroid coil resonating with a few capacitors, one of which will be a variable capacitor allowing the frequency to vary. My favorite circuit is the Colpitts, since the coil requires no tap. Here's the basic form of the circuit, for a bipolar transistor. See Fig. 6.

Output can be taken from many places; often from the transistor emitter. In this case, the capacitance resonating with the coil is the series combination of C3, C1 and C2.

The biasing resistors Rb1, Rb2 and Re are chosen to linearly bias the transistor, similar to an emitter follower. Our

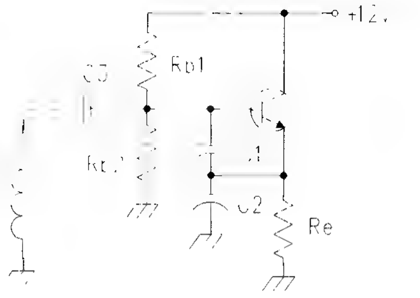


Fig. 6

2N2222 transistor has enough gain at 7 Mhz. to allow quite a range of possible collector currents to give good performance. We'll keep it low so as to limit self-heating: about 1 ma. D.C. voltage across Re should be half of the supply, or 6v. A 5.6K resistor is needed here.

We want Rb1 and Rb2 to be large so that the resonant circuit is not loaded. To keep our parts count down, we'll make them the same size, since base voltage is close to half the supply. We're using a 33k resistor elsewhere, so let's use the same value here too. If we make Rb1 and Rb2 too big, base voltage will be too low, since base current causes a larger voltage drop across Rb1.

Let's turn our attention to the resonating components, starting with C2. Its capacitive reactance should be much lower than Re, however if its too low, the oscillator won't oscillate. Let's start by finding capacitive reactance equal to Re:

C=1/(2*PI*7e6*5600) = 4 pf

If we make C2 one-hundred times Re, we should still have a nice high-Q tank, and yet have enough gain to maintain oscillation. A capacitance of 470pf is about right. We'll make C1 the same value to keep our parts count low again. Can we make C3 470pf as well? It should really be smaller, about half C2. We're using a 330pf capacitor elsewhere, so let's make C3 330pf. The

total series combination of C1, C2 and C3 is 137pf. Since we want to tune the 40M band of 300Khz, what variable capacitor is required?

A 7 to 7.3 Mhz frequency ratio is a 4.3% change. Since capacitance and frequency have a squared relationship, a capacitance change of twice 4.3% is required. 137pf/1.083 = 127pf The total capacitance must be varied by about 10pf. A varactor diode could be used to give this range.

We must allow some method of bringing the tuning range within the 40M band, since the toroid coil could easily be slightly off our designed inductance. We can always remove or add a turn, but this is a coarse adjustment. We should include a small trimmer capacitor for finer adjustment. Since trimmers often have undesireable temperature stability, a small range should be used. What inductance is required?

1/((2*PI*f)^2 C), 1/(39.478*49e12*137e-12) or 3.77 uH.

A T50-2 toroid would require 100*SQRT(3.77/49) = 28 turns

If you try to simulate this oscillator in PSPICE, you'll find that it won't oscillate. REAL oscillators start up either from a power-on transient, or from noise. SPICE is noiseless, and it defaults to starting all components biased (no power-up transient). You actually have to "kick-start" SPICE in order to get the oscillator going. You can do this by specifying an initial condition on one of the capacitors - something other than its quiescent bias voltage. Then the oscillations will build from there.

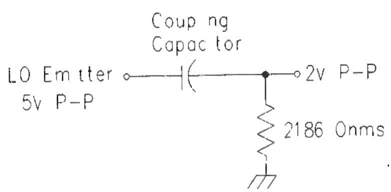
R.F. amplitude from this oscillator is surprisingly difficult to predict exactly. This is so because all oscillators limit amplitude through some non-linear means. So coupling this oscillator into the mixer will require some cut-and-try. The appropriate place to tap off some signal is from the emitter of the oscillator transistor. The mixer input inpedance will be fairly high. At 7 Mhz, the current gain of the mixer's 2N2222 VFO input is about 14. So input impedance is roughly 14*470 + hie = 6580+1000 ohms. This resistance is in parallel with the bias resistors, which will bring down the input impedance somewhat. You should choose a coupling capacitor only big enough to give the required injection of 2v p-p.

Let's assume that the emitter of the oscillator has a 7Mhz sinewave of 5v p-p amplitude. What capacitive coupling reactance will result in 2v p-p appearing at the base of the mixing transistor?

Composite input resistance at the mixer base is:

1/ (1/5600 + 1/6800 + 1/7580) = 2186 ohms.

This input resistance is substantially resistive. We'll assume that the oscillator emitter is at an impedance level that's low compared with this resistance. So here's the problem - find the value of the coupling capacitor:



You might simplify the problem and simply treat this as a simple voltage divider:

Xc/2186 = 3/2, Xc = 3/2(2186).
C=(1/2*PI*7e6*3279)=69pf

This will be close, but not quite correct, because reactances and resistances should be treated as complex numbers. But since we're approximating all this anyway, its a good place to start.

And that's the design done. Its amazing to look through the literature afterward, and see variations of these circuits with almost identical component values - designs done by gurus like DeMaw and Hayward.

NorCal QRP to the Field Results - 1997

by Bob Farnworth, WU7F
6822 131 SE
Bellevue, WA 98006

The second annual QRP to the Field Operating contest was another rousing success. The them for this year was operating from places where strange things have happend. Ron Stark, Paul Harden, Bob Follett and Doug Hendricks even went to Area 51 to operate. But no logs were turned in, and there was a report that the "Men in Black" confiscated them. Lots of entries and the winner scored almost 5K more points than last years. Certificates were presented to the top ten finishers and participant certificates were sent to those who mailed a SASE. This year's contest will be held on Saturday, April 25th with the theme "Run to the Border". Look for details elsewhere in this issue.

NorCal would like to say a special thank you to Bob Farnworth, WU7F who has been our contest manager for the past two years. He has done an outstanding job and we appreciate his efforts. But Bob has asked that we find a replacement for him as he wants out of the job. Thank you Bob for all of your excellent work. The new contest manager for NorCal is Joe Gervais, AB7TT.

Soapbox - QRP TO THE FIELD - 1997

Fun contest, with lots of QRP activity. This contest would be even more exciting if SPCs were multipliers. I was amazed that we could get so many responses by calling CQ with 1 watt. **K6JI** with **WT7F** & **KQ6MW**; Lots of QRN from thunder storms, but fun. **N5SAN**; Too windy & rainy to venture very far, so much for "Paradise". **WB6FZH/KH6**; Decided at last minute to head out, forgot to bring sling shot to get antenna up high. Still had fun. **WD9IAB**; Kayaked from Dash Point, WA to Maury Island, about 2 miles. Super view of Mt. Ranier and 180 degree coverage to the east. On air at 0820 local. Halted at 1500 local to beat storm back to car. I lost and spent Saturday evening with rain, wind, and more rain. The view from the tent was terrific when rain let up. Sunday no better, spent 4 hours kayaking 10 miles along shore to make mad dash across to Tacoma & pick up by XYL. Compliments to W0HMD (MO) for landline to XYL. **N7MOB**; QRP while conducting "SAR" dog training,. Great fun but condx awful. Cold & rain all weekend. **KS4DU**; Thunderstorms throughout contest period with S9+ rain static, Bummer. **N4BP**; Traveled to Boscawen/Canterbury, NH. Chose this location for two strange events; Hannah Duston's escape from Indian captors in 1697, and Betty and Barney Hill's abducted by a UFO in the 60's. Four visitors, who went away convinced we were a bit touched. Brisk breeze most of day. Had photos taken by the Hannah Duston Memorial. We didn't get abducted. We had fun. **KA1AXY** with **KC1TD**; QTH: Martian landing site ("War of the Worlds" broadcast, 1936). If there was a Martian landing on QTTF, they did so in Earth forms of Canadian Geese or human population. **N2CQ**; QTH: My warm, dry, quiet shack! In Big Bend Park for the previous 5 days, I didn't have much enthusiasm to pitch a tent, again. **W5FN**; Site located off FR201, 1 mile No. of State Route 87, Gila County, AZ. Elevation 4700 ft. **KG7RS**; I was only able to operate 3 hours, maritime mobile (sailboat), with emergency power, R-7 vertical and Norcal 40A. **AF7Y**; Power about 0.9 watt. I

made twice as many qso's last year using 3 watts. **W0YSE**; I operated from a mountain top in Northern Idaho. Backpacked all the equipment in and had a great time. **AB7TK**; QTH: Northern Kathyrn, AB about 30 miles NE of Calgary. Antenna was a portable trailer mounted, 60 foot tower with a 3 El Tribander. Strange events: Filming of Viper Series and home of the Greatest Outdoor show on Earth - Calgary Stampede. **VE6DN** - op's - **VE6NJK**, **VE6CGO**, **VE6ZAA**, **VE6DMD**, & **VE6EY**; QTH: Seacliff Beach (Concrete Boat), Aptos, CA. **K1MG**; QTH: Brevoort Park in the north end of Columbus, OH. Cool in the early morning, the day was shirt sleeve weather in the high 60's. **K8QR**; Band and local QRN were poor. Although sigs were not strong (&QSB) seemed like more participation. **W8TIM** (x-WA8TIM); Huge snowstorm on 4/24 really messed things up in foothills and mountains. Changed my plan to operating on the plains. Not a tree to be found. Companions were a bunch of mechanical monkeys and one lost cow. Band had an excessive amount of QSB, but it sure was fun. **WU0L**; Its lonely out there, but the contest was fun. **AE4IC**; QTH: Fort Hamilton by Verazano Bridge, Brooklyn, NY. **KB2VTN**; Chose to operate from the San Andreas Fault Zone. Homes were severely damaged in the 1906 Great Quake and again in 1989. Homes worth millions of dollars each. Operated 5 hours with about half time answering questions from cyclists, motorcyclists, hikers and Ferrari & Porsche racers. **AB6SO**; QTH: Ft. Hamilton Army Base, Brooklyn, NY. We had a perfect day, bright sun, breeze, and temps in the 60s. **N2TO** with **KB2VTN** & **WW2W**: QTH: Goldsboro, PA along the western shore of the Susquehanna River, one mile from the Three Mile Island Nuclear Power Reactors. **KT3A**; The field day started at 11:00 PM local. I guess everyone had gone to bed, so all-in-all not to bad seeing band conditions really bad at the moment. Best 73's from down-under. **VK3FHH** (X-VK3KMU); In the spirit of strange locations, I decided to stay at home in Phoenixville, PA "Home of the Blob". This was where scenes from the 1958 scifi classic The Blob were filmed. **WB3GCK**; Expedition to top of Kennesaw Mountain, GA. 30 miles NW of Atlanta and 1808 feet above SL Kennesaw Mountain National Battlefield is rich in Civil War history. Awesome views of the surrounding territory 800 feet below. **W4QO**; QTH: near Donner Pass where infamous Donner Party struggled to survive winter of 1846-47 at 6000 feet. Some resorted to cannibalism and most died. Flew there in a airplane without air traffic control, I was a Unidentified Flying Object. **N7TN**; QTH: Christopher Creek Campground, near Payson, AZ. Reducing power to 0.95 w. didn't hurt QSO rate as much as expected, and really boosted our points. We almost doubled last years points. Families came along for a pleasant outdoor weekend anong the pines. **WB4ZKA** with **KG7WS**; Only did an hour, wx was too nice here in WI. **WA9PWP**; I had trouble getting information about the contest. We need to do a better job of getting the word out. It should be in all the mags, at least two months in advance. Willing to be the publicity chairman next year. **K0HPS**; (Where did all the rest of you guys find out about the contest? Bob) QTH: John's Creek Mountain in Craig County, VA, near the crash site of Audie Murphy, 1971. **KC4WXB**; In spite of 6 ins. of rain and thunderstorms, I managed to spend most of the day with the antenna connected. Just couldn't hear much but lots of noise. **KE4YH**; QTH: Scenic Hill School, near Kent, WA. **WA2OCG/7**; I did not get a chance to operate away from the house but had a good time anyway. **AK1P**; Stumbled into this late in the day, then the band went south. I wish I had gotten on earlier. **K4AT**; QTH: Daniels Park, south

of Denver. **W0CQC** op-**AA0XI**; Condx very poor, static and QSB. **K0LWV**; I figured that by running <1 watt, I would get at least 1/2 the contacts of running 5 watts and therefore achieve a higher score. Wrong! Once condx got better, I found there were lots of people who hear me out west. Running 1 w is neat but if more folks ran the full gallon the test would be livelier. **N2VPK**; QTH: Marymoor Park, near Redmond, WA. Outdoor Sword Fighting competition was directly in front of our operating tent, so we had entertainment while waiting for bands to open. **W6EMT** with **WU7F**; QTH: Mystery Cave State Park, MN. We attempted SSB with no success. **KG0ZT** with **AA0SM**; I gave the QRP Plus an unusual outing in the woods, hoping for some SSB. Should have stuck with my trusty Sierra. **AA7QU**; Les started at 1300Z and operated for the most part, I showed up 2300Z and took over the operation and wound up the contest. We had a great time and really enjoyed the set up rather than the tear down. **W5ON** ops-**K5LG** & **N5OE**; QTH: Rancho Seco, a decommissioned nuclear power plant, Sacramento County, CA. **WB6RUU** with **WA9WAC**; QTH: Reyes Peak Campground, Los Padres National Forest, Ventura County, CA. 5 watts out on 40m & .95 watt on 20m (sick transmitter on 20m). **N6MM**; The W6MMA mod to the SLV performed extremely well. Very impressive for a simple field antenna. Sure would like to be able to use more than 8 continuous hours, felt like other contacts were wasted. **N7KT**; I picked last years site again because it provides 360 deg.s of spectacular CA view. Last year a neighbor took me up on horseback. This year I toughed it out making three trips up with equipment. Totally exhausting. **AC6NT**; I operated QTTF from directly on top of the San Andreas Fault. The location was the Los Trancos Open Space Preserve in the Santa Cruz Mountains, at the edge of Palo Alto, CA. **WA2CRQ**; QTH: Lost Dutchman Mine, 12 miles west of Peoria, AZ. Next year I'll have a homebrew rig, extra multiplier makes a big difference in the final score. **W5VBO**; Set out to achieve the objectives: improve last years score, get used to new call, a new operating location that would offer better conditions. All objectives were met. I gave up working SSB. **N6KZ** (x-KG6VI); QTH: Abandoned 160 foot commercial radio tower, about 3 miles outside of Gate City, VA. It is located in the middle of a "moofer pie factory". I had moofer visitors the entire contest period, I think some of them were interested in morse code, from the way they were acting. **N4ROA**;

CALL,SCORE,Q'S,SPC, QTH,PWR,RIG, ANTENNA,TIME

K6JI, 11520, 96, CA,F, 1, WILD.SIERRA, 40M DELTA LP.,7:22
(+WT7F,KQ6MW)

WB4ZKA 8160, 82, AZ, F, 1, NE4040, MFJ 9020, 40M C.WINDOM, 6
(+KG7WS)

WA6NAE, 7800, 65, CA, F, 1, SIERRA, 20M HALF SQ.,40M ZEPP, 7:50
(+N6WG)

N6MM, 6180, 103, CA, F, 5, OHR 400, TRI-BD BM.,40M DIPOLE, 8

W0CQC, 4620, 77, CO, F, 5, OHR 400, 20&40M HUSTLER MOBILE, 7:40

N4ROA, 4200, 105, VA, F, 5, QRP+, 160M FULL WAVE INV. VEE, 2:10

WB6RUU, 4200, 35, CA, F, 1, NC40A, 40M DIPOLE, 7:26
(+WA9WAC)

CALL, SCORE, Q'S, SPC, QTH, PWR, RIG & ANTENNA, TIME

AA7QU, 4080, 102, OR, F, 5, QRP+, INV. VEE @ 26', 7:24
N4BP, 4000, 99, FL, H, 1, FT-1000, 7DXX BM.@ 45', 40M DIPOLE, 8
W7HQJ, 3740, 88, WA, F, 5, NC40, IC706,2M, 40M V, 20M DIPOLE, 8
N6KZ, 3720, 93, CA, F, 5, QRP+, 32' VERTICAL, 8
W5ON, 3640, 91, MO, F, 5, IC725, TRI-BD, DEL.LP.,DIPOLE,GAP V, 7:47
(OP'S K5LG, N5OE)
W5VBO, 3560, 89, AZ, F, 5, QRP+, HB 20M-10' VERT, 8
N7KT, 3540, 59, AZ, F, 5, OHR-400, MMA-SLV VERTICAL, 7:46
WU0L, 3300, 55, CO, F, 5, WU0L HB 3-BAND, 20M VERTICAL, 4
AE4IC, 3300, 55, NC, F, 5, NW40, NW20, W3EDP, 85' LW W/17'RAD, 7
K8QR, 3300, 55, OH, F, 5, OHR-400, W. SIERRA, 20&40 D L.S, SLV, 7:50
(CQRP CLUB) OP-K8IDN
WA2CRQ, 3060, 51, CA, F, 5, NC-40A, 40M HAMSTICK, 7:35
AB7TK, 3000, 50, ID, F, 5, WILD. SIERRA, 20 M DIPOLE AT 32', 8
VE6DN, 3000, 25, AB F, 1, HW-9, TRIBAND 60' PRT. TOWER, 6:40
(5 OP.S-CALGARY QRP CLUB)
K1MG, 2920, 73, CA, F, 5, IC706, W1QG 40M,MMASLV,BEACH SPL, 7:53
WB4TPW, 2700, 45, OR, F, 5, NC SIERRA, 20M DIPOLE @ 30', 2:22
AC6NT, 2640, 66, CA, F, 5, MFJ 9020, 20M ISOTRON, INV. VEE, 8
N2VPK, 2520, 21, NY, F, 1, SW40, OHR400,ARGO 556, 40/20 FAN DIPOLE , 8
KG0ZT, 2100, 55, MN, F, 5, OHR400,EXPII,EXPI, 102' DIPOLE @ 30', SLV 7:05
(+AA0SM)
N0UR, 1680, 84, MN, H, 5, IC73, 5:26
WJ4P, 1680, 28, SC, H, 1, OHR400, GAP VERTICAL, 3:02
W4QO, 1640, 41, GA, F, 5, QRP+, INV. VEE, 5:17
W6EMT, 1600, 27, WA, F, 5, NW40, 20, MFJ 9420, 2EL 20M BM@20', HB VER 6
(+WU7F)
N7TN, 1440, 24, CA, F, 5, NC40A + KC1, MMA SLV, 2:41
W8TIM, 1380, 23, MI, H, 1, HB SW40, DIPOLE, 6:31
N7MOB, 1320, 22, WA, F, 5, HW-8, 20M VERTICAL, 6:30
AF7Y / MM, 1320, 22, CA, F, 5, NC40A, R7 ON SAILBOAT, 4
WD3P, 1300, 65, MD, H, 5, TS570S, DIPOLE, 6:53
KB2VTN, 1260, 23, NY, F, 5, NW40, ICOM, 6:23
N2TO, 1240, 31, NY, F, 5, NW40,IC728,IC735,MFJ 9420, 40M DELTA LOOP, 7
(+KB2VTN, WW2W)
KS4XO, 1240, 31, VA, F, 5, HW-8, TAC-1, 7:31
AB6SO, 1200, 20, CA, F, 5, NC40, 40M LOOP, 4:42
WA2OCG, 1200, 20, WA, F, 5, OHR400, 20M & 40M HAMSTICKS, 7:44
WB3GCK, 1200 20, PA, F, 1, SW40, GM20, HB VERT, END FED INV. VEE, 4:45
AA1PB, 1110, 37, VT, H, 5, 7:38

W0YSE, 1040, 13, UT, F, 1, MFJ 9020, 40/20 WINDOM @20', 6:06
KE4YH, 1000, 25, FL, H, 1, OMNI VI, R7 (BASE @ 10' HIGH), 8
KT3A, 960, 16, PA, F, 5, NC40, INV. VEE @ 35', 2:15
W5YA , 900, 30, NM, H, 5, NC40A, PHASED LOOPS, 6:44
(OP-KT5X)
KC4WXB, 880, 22, VA, F, 5, TAC-1, 40M DIPOLE @ 60', 4:12
K0HPS, 840, 14, CA, OFFICE, 1, NC40, DOUBLE BAZOOKA, 6:03
K5OI, 840, 28, NM, H, 5, NC40A, OHR SPIRIT, GAP VERTICAL, 8
KA1AXY, 820, 21, NH, F, 5, QRP+, 40M INV. VEE, 20M K1LOG VERTI, 6:37
(+KC1TD)
N2CQ , 800, 17, NJ, F, 5, SIERRA, ARGO, VERT, HALF SQUARE, 5
(NJ QRP CLUB)
HP1AC, 780, 29, PAN, H, 5, TS430S, K9AY 20M, LONGWIRE, TA33JR, 2:19
KD0SU, 750, 25, CO, H, 5, SIERRA, 8
W5FN, 700, 35, TX, H, 5, QRP+, 40M VERT. ARRAY, 135' DIPOLE , 5:17
KG7RS, 660, 11, AZ, F, 5, OHR EXP II, INV VEE @ 10', 7:28
KG0MZ, 660, 22, KS, H, 5, OHR400, G5RV @ 30'
AC6KW, 600, 20, CA, H, 5, SIERRA, 20M YAGI , 40M ROTATE. DIPOLE, 1:43
KS4DU, 520, 13, SC, F, 5, IC706, DIPOLE, 5:14
K0LWV, 520, 26, MO, H, 5, TS520, CTR. FED ZEPP @ 25', 5:32
N5SAN, 500, 25, AR, H, 5, FT747GX, SLOPER DIPOLE, 6:15
AK1P, 480, 24, CA, H, 5, TS570D, HF5V @ 15', 7:36
KB7QXY, 440, 22, AZ, H, 5, HW7, ARGO 556, 6
K4AT, 400, 20, KY, H, 5, TS870, 80/40 DIPOLE, 1
NI0A, 380, 19, MN, H, 5, QPR++, END FED ZEPP, 7:22
AK0B, 300, 15, MO, H, 5, CUBIC 103, LONG WIRE, 2:09
WA9PWP, 280, 14, WI, H, 5, ARGOSY II, VERT. , END FED WIRE, 4:41
WD9IAB, 240, 4, WI, F, 5, SW 40-40, END FED COAX DIPOLE, 1:22
KH6/WB6FZH, 180, 9, HI, H, 5, TENTEC C-21, VERTICAL, 5:17
VK3FHH, 160, 8, AUST, H, 5, QRP+, G5RV, 8
K4KJP, 120, 6, FL, H, 5, TENTEC C-22, DX-77 VERT ON ROOF, 1:23
WA1OFT, 100, 5, RI, H, 5, IC706, 80M ZEPP, R5, 3:17

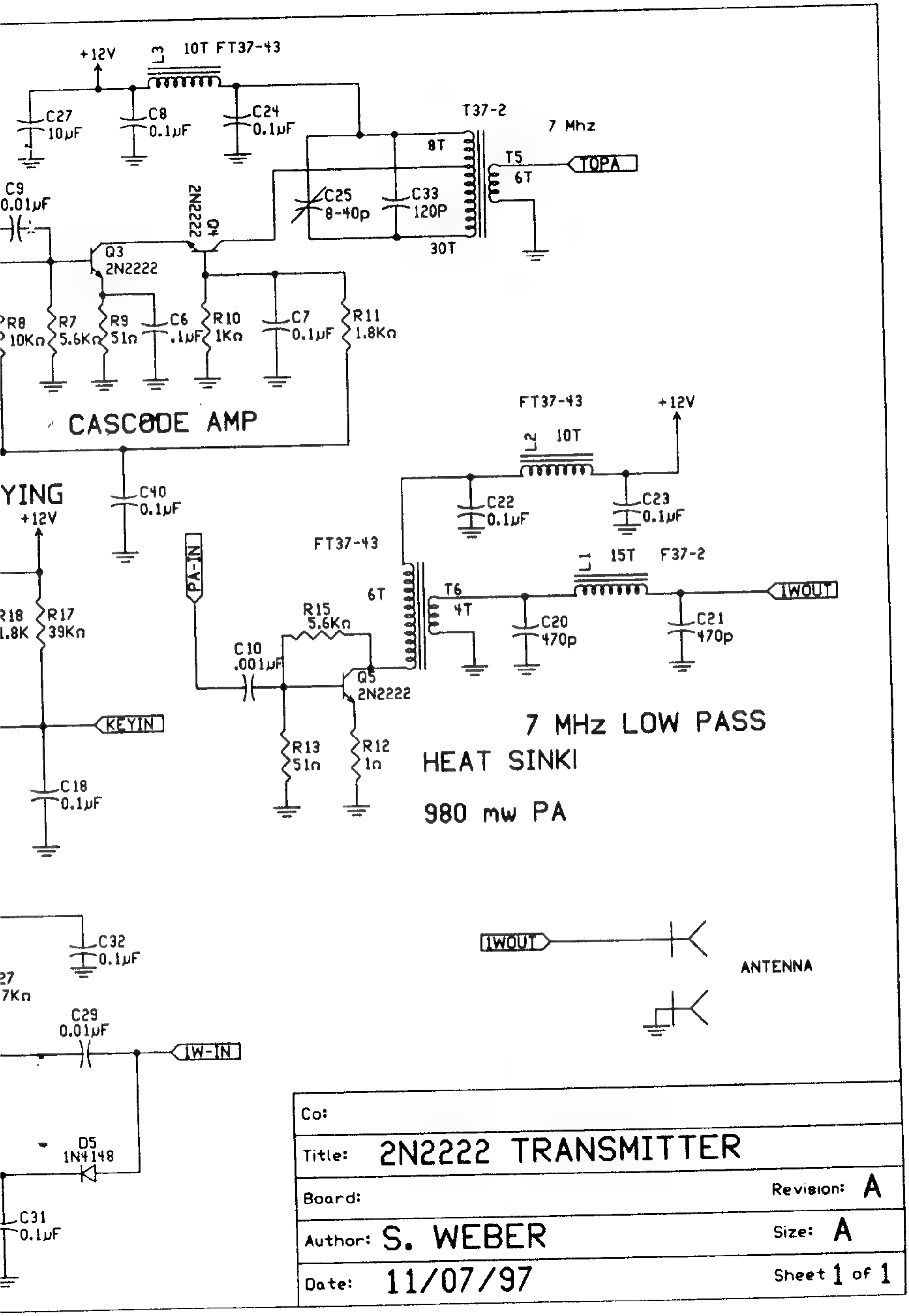
My 2N2 Rig Design for the NorCal Dayton Building Contest

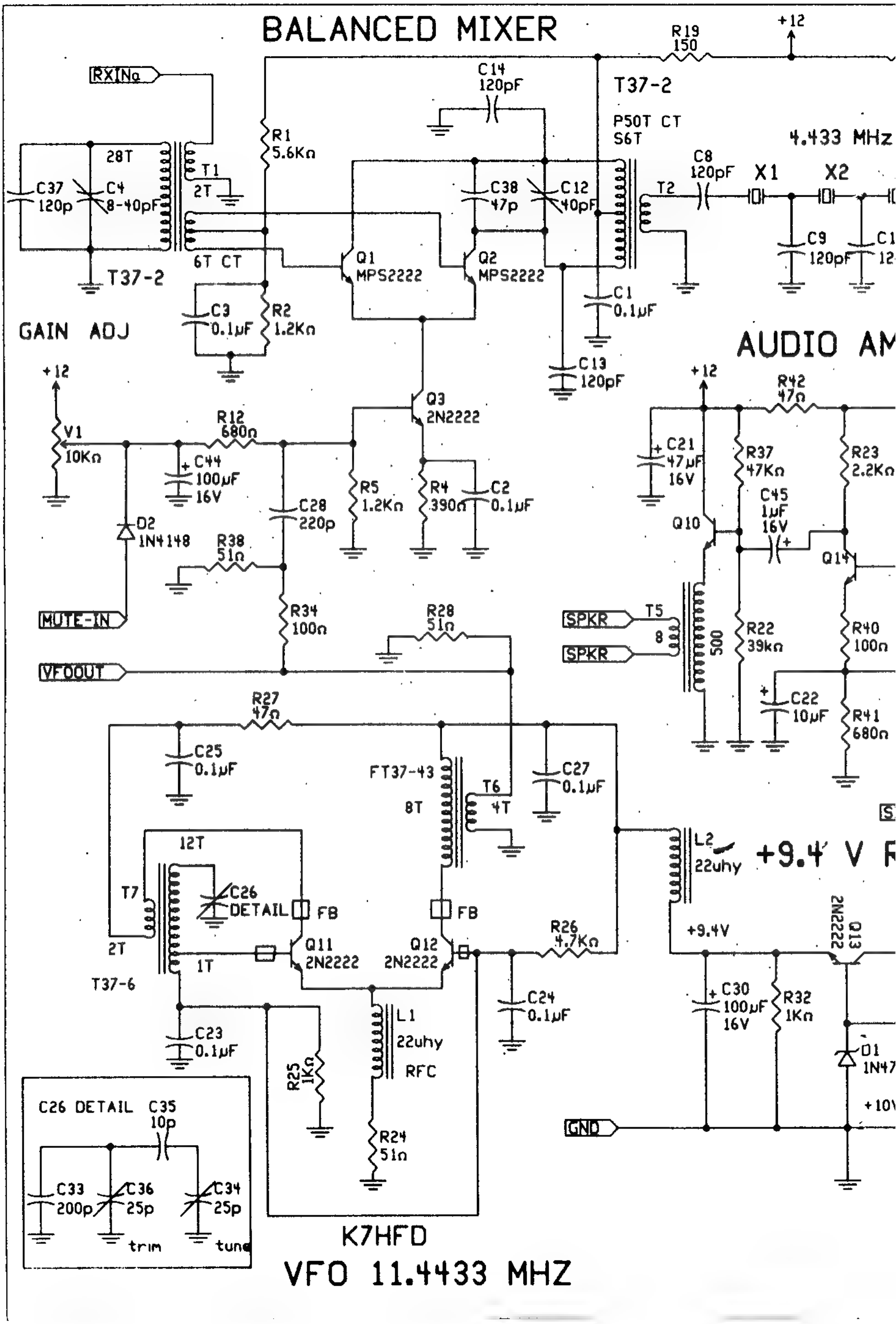
by, Steven Weber, KD1JV
kd1jv@moose.ncia.net

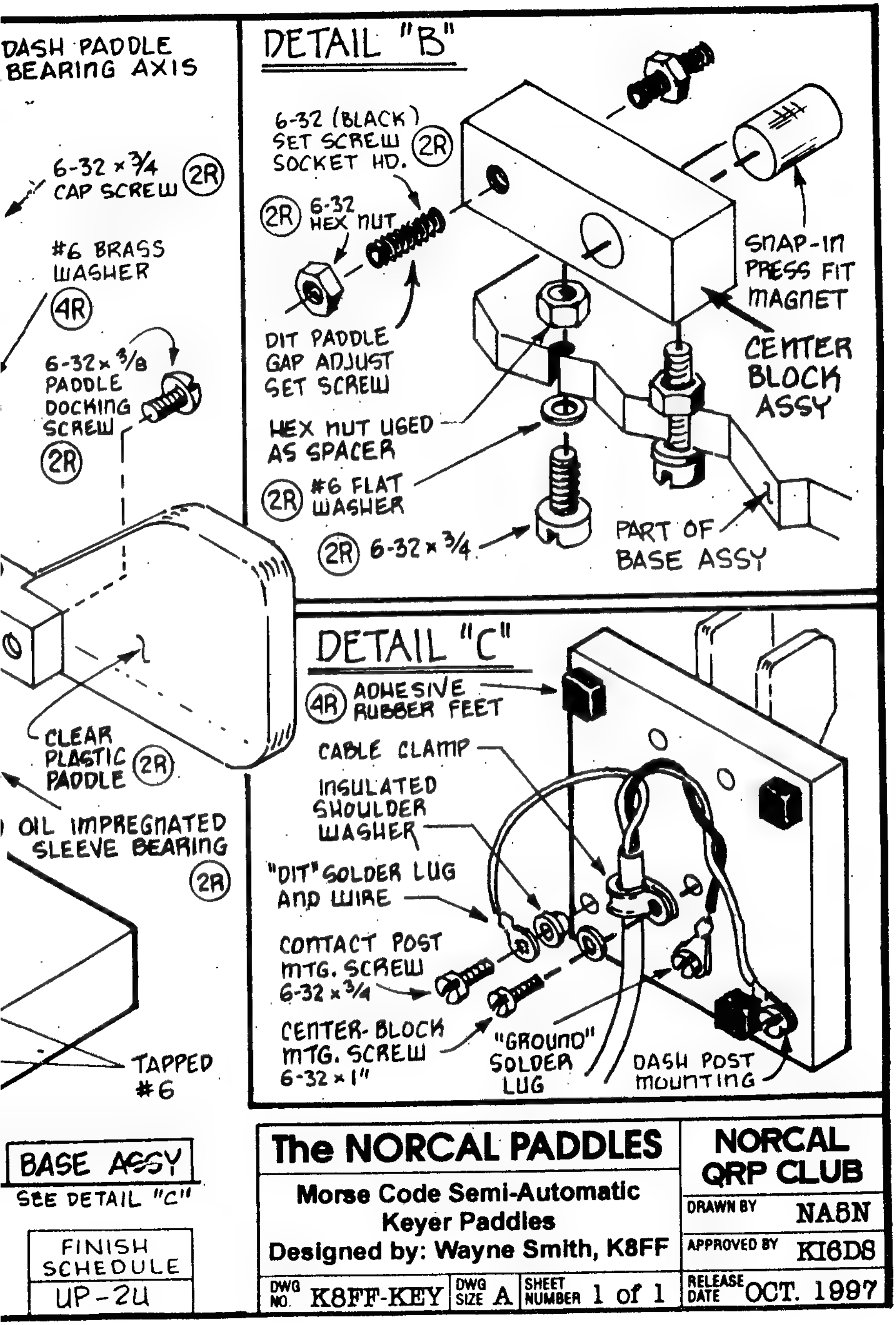
When I first saw the 2N2222 building contest announced on qrp-l, the logical side of my brain thought "What an insane thing to do!", while the creative side was thinking, "Okay, how am I going to do this?". About a week later, I know how I was going to do it, as I had done it. Of course, it took a little longer to get it really, truly done.

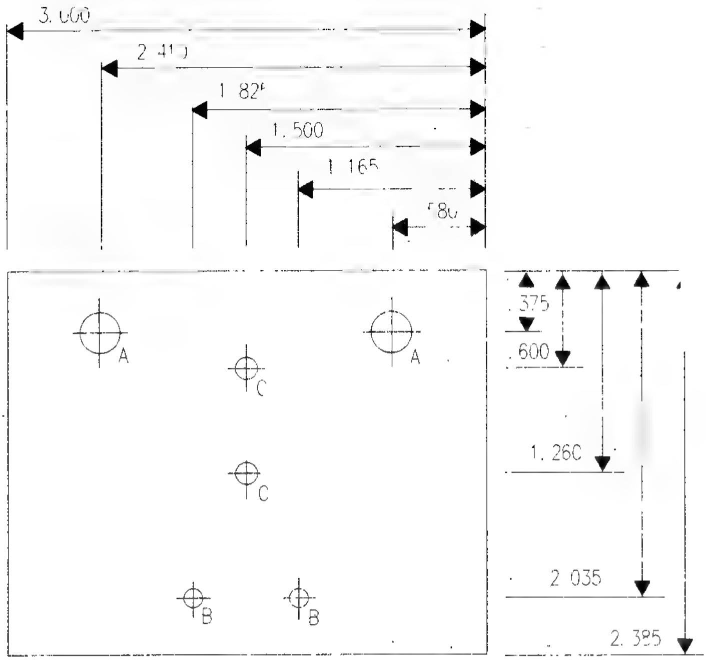
Design Choices

I could have taken the easy way out and built some kind of simple Direct Conversion rig, but I wanted a real radio that would work well. The results surprised me.

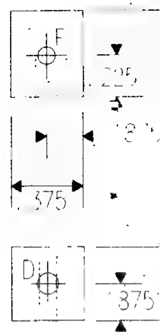

+12V
L3 10T FT37-43
C27 10µF
C8 0.1µF
C24 0.1µF
T37-2
7 Mhz
8T
T5
TOPA
6T
C9 0.01µF
Q4 2N2222
C25 8-40p
C33 120P
30T
Q3 2N2222
R8 10Kn
R7 5.6Kn
R9 51n
C6 .1µF
R10 1Kn
C7 0.1µF
R11 1.8Kn
CASCODE AMP
FT37-43
+12V
L2 10T
C40 0.1µF
C22 0.1µF
C23 0.1µF
PA-IN
FT37-43
L1 15T F37-2
6T
T6
4T
1WOUT
R17 39Kn
R15 5.6Kn
C20 470p
C21 470p
C10 .001µF
Q5 2N2222
KEYIN
7 MHz LOW PASS
R13 51n
R12 1n
HEAT SINK!
C18 0.1µF
980 mw PA
C32 0.1µF
1WOUT
ANTENNA
C29 0.01µF
1W-IN
D5 1N4148
C31 0.1µF
Co:
Title: 2N2222 TRANSMITTER
Board:
Revision: A
Author: S. WEBER
Size: A
Date: 11/07/97
Sheet 1 of 1


BALANCED MIXER
RXINa
28T
T1
2T
C37 120p
C4 8-40pF
6T CT
T37-2
GAIN ADJ
R1 5.6Kn
R2 1.2Kn
C3 0.1µF
C14 120pF
Q1 MPS2222
Q2 MPS2222
C38 47p
C12 40pF
T37-2
P50T CT
S6T
T2
C8 120pF
X1
X2
4.433 MHz
C9 120pF
C1 0.1µF
C13 120pF
R19 150
+12
Q3 2N2222
R4 390n
C2 0.1µF
R5 1.2Kn
V1 10Kn
R12 680n
C44 100µF 16V
C28 220p
D2 1N4148
R38 51n
MUTE-IN
R34 100n
R28 51n
VFOOUT
AUDIO AM
R42 47n
C21 47µF 16V
R37 47Kn
R23 2.2Kn
C45 1µF 16V
Q10
Q14
SPKR
SPKR
T5
8
500
R22 39kn
R40 100n
C22 10µF
R41 680n
R27 47n
C25 0.1µF
FT37-43
8T
T6
4T
C27 0.1µF
L2 22uhy
+9.4 V
12T
T7
C26 DETAIL
FB
FB
2T
1T
T37-6
Q11 2N2222
Q12 2N2222
R26 4.7Kn
C24 0.1µF
C23 0.1µF
R25 1Kn
L1 22uhy RFC
R24 51n
+9.4V
C30 100µF 16V
R32 1Kn
Q13 2N2222
D1
+10
GND
C26 DETAIL
C35 10p
C33 200p
C36 25p trim
C34 25p tune
K7HFD
VFO 11.4433 MHZ

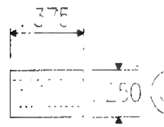

DASH PADDLE BEARING AXIS
6-32 × 3/4 CAP SCREW 2R
#6 BRASS WASHER 4R
6-32 × 3/8 PADDLE DOCKING SCREW 2R
CLEAR PLASTIC PADDLE 2R
OIL IMPREGNATED SLEEVE BEARING 2R
TAPPED #6
BASE ASSY
SEE DETAIL "C"
FINISH SCHEDULE
UP-2U
DETAIL "B"
6-32 (BLACK) SET SCREW SOCKET HD. 2R
2R 6-32 HEX NUT
SNAP-IN PRESS FIT MAGNET
CENTER BLOCK ASSY
DIT PADDLE GAP ADJUST SET SCREW
HEX NUT USED AS SPACER
2R #6 FLAT WASHER
2R 6-32 × 3/4
PART OF BASE ASSY
DETAIL "C"
4R ADHESIVE RUBBER FEET
CABLE CLAMP
INSULATED SHOULDER WASHER
"DIT" SOLDER LUG AND WIRE
CONTACT POST MTG. SCREW 6-32 × 3/4
CENTER-BLOCK MTG. SCREW 6-32 × 1"
"GROUND" SOLDER LUG
DASH POST MOUNTING
The NORCAL PADDLES
Morse Code Semi-Automatic Keyer Paddles
Designed by: Wayne Smith, K8FF
NORCAL QRP CLUB
DRAWN BY NA8N
APPROVED BY KI6DS
DWG NO. K8FF-KEY
DWG SIZE A
SHEET NUMBER 1 of 1
RELEASE DATE OCT. 1997



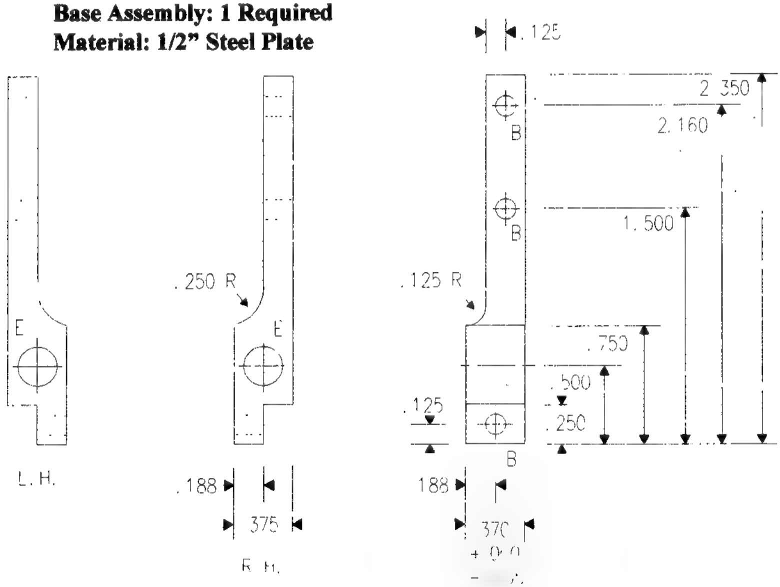
Base Assembly: 1 Required
Material: 1/2" Steel Plate



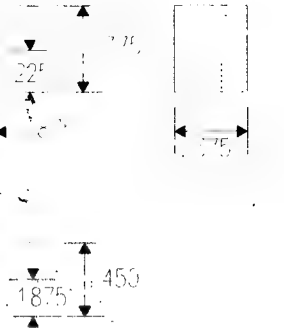
Contact Post As
Material: Brass



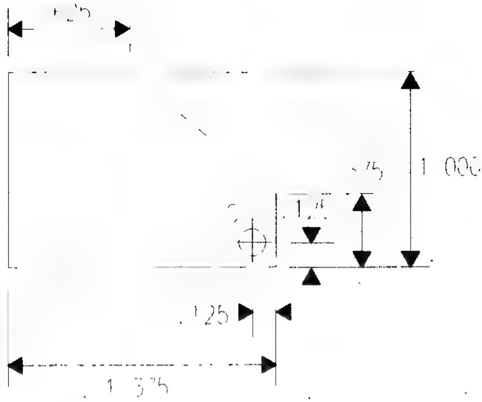
Bushing: 2 Req
Material: Bron



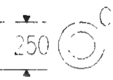
Dit an Dah Shafts: 1 of each required
Material: Brass



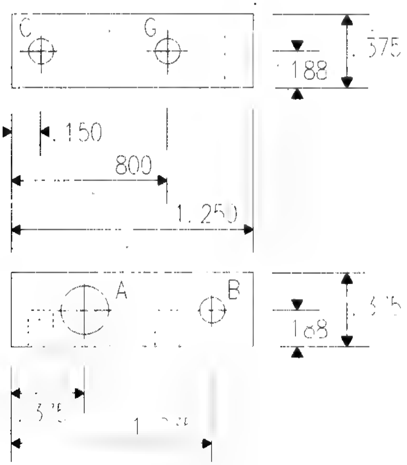
Post Assembly: 2 Required
l: Brass



Paddle Handles: 2 Required
Material: Clear Acrylic, 3/16" Sheet



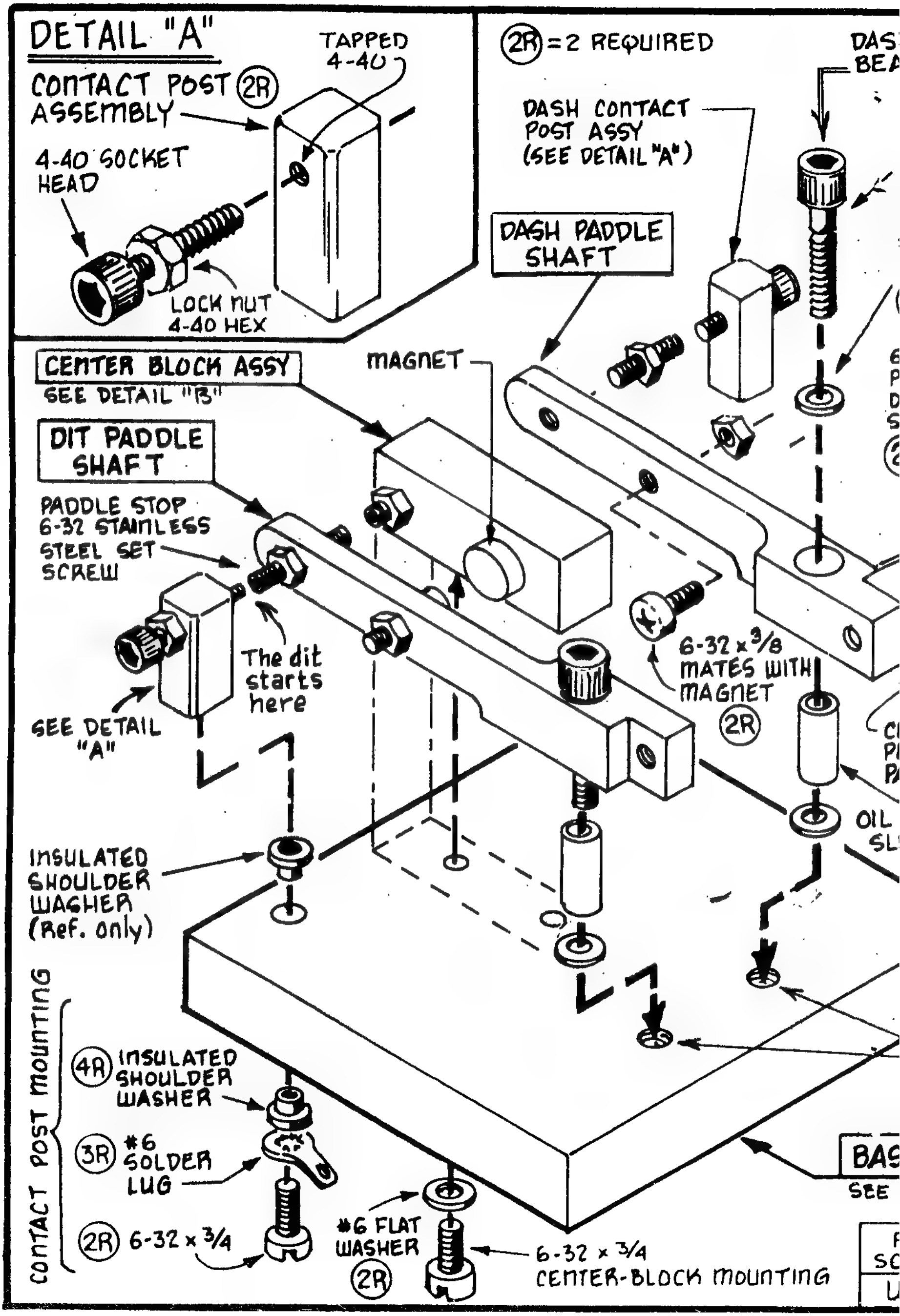
: 2 Required
l: Bronze



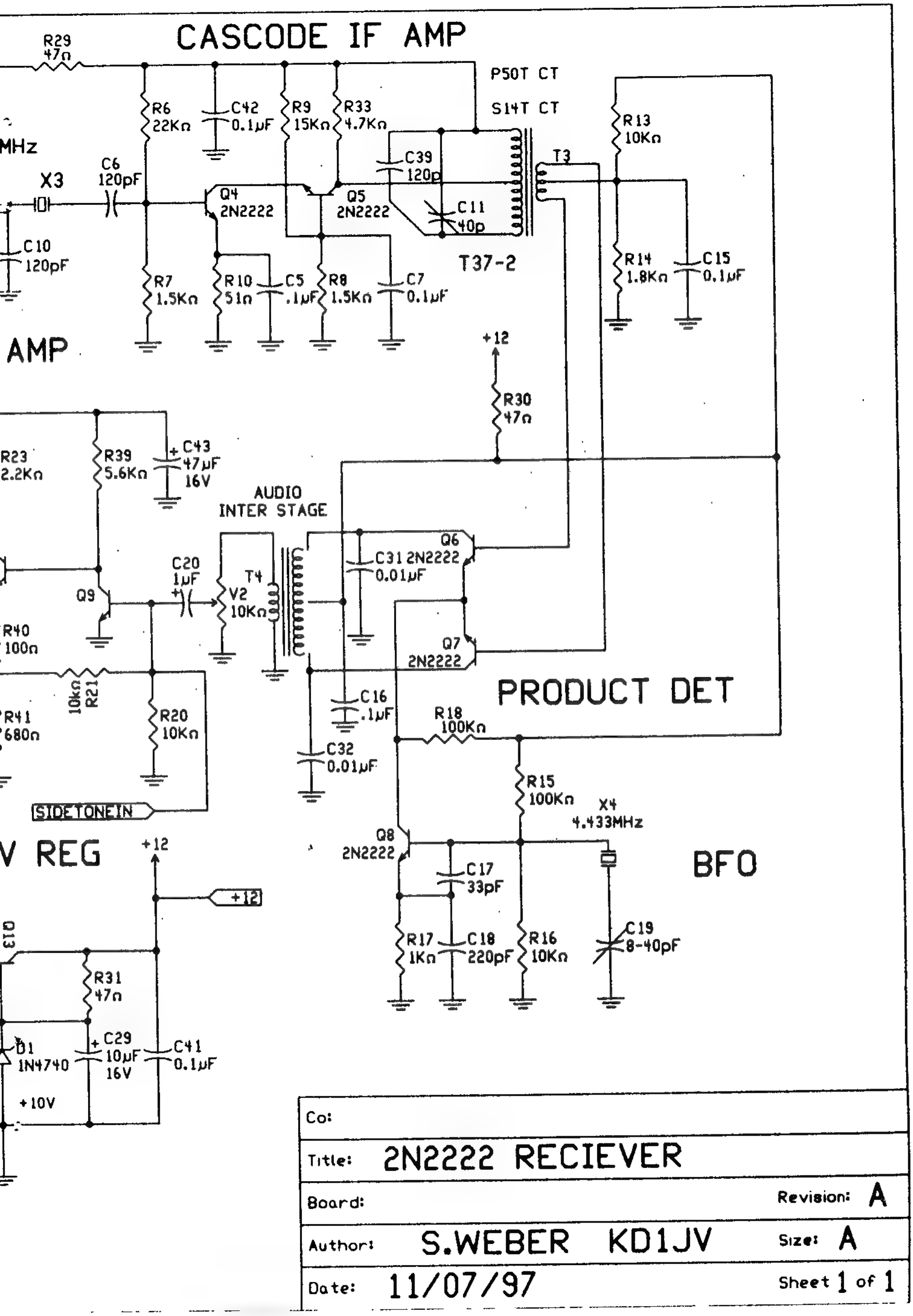
Center Magnet Assembly: 1 Required
Material: Brass

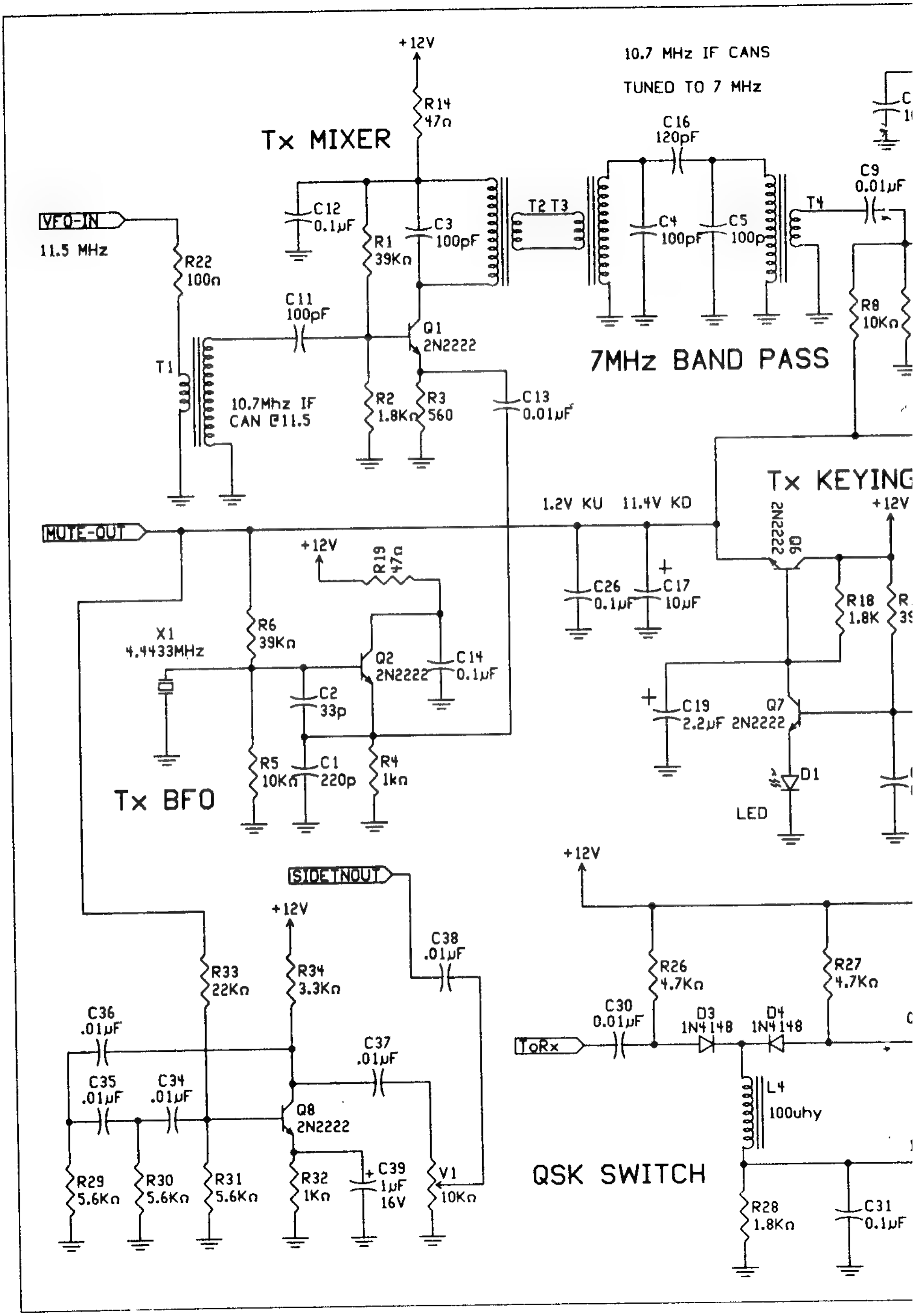
Holes:
A = .250 Thru
B = 6-32 Tapped Thru
C = .140 Thru
D = 4-40 Tapped Thru
E = Ream .2535 Thru
F = Tap 6-32, .250 Deep
G = Tap 6-32, .188 Deep
Tolerances:
.0 +/- .015
.00 +/- .010
.000 +/- .005
Frac. +/- .015

NorCal K8FF Paddles
Designed by Wayne Smith, K8FF
Drawing by KI6DS, Sheet 1 of 1
November 1997
KE6RIE, Machinist Consultant



DETAIL "A"
CONTACT POST 2R ASSEMBLY
TAPPED 4-40
4-40 SOCKET HEAD
LOCK NUT 4-40 HEX
2R = 2 REQUIRED
DASH CONTACT POST ASSY (SEE DETAIL "A")
DASH PADDLE SHAFT
CENTER BLOCK ASSY
SEE DETAIL "B"
MAGNET
DIT PADDLE SHAFT
PADDLE STOP 6-32 STAINLESS STEEL SET SCREW
The dit starts here
SEE DETAIL "A"
6-32 x 3/8 MATES WITH MAGNET 2R
INSULATED SHOULDER WASHER (Ref. only)
CONTACT POST MOUNTING
4R INSULATED SHOULDER WASHER
3R #6 SOLDER LUG
2R 6-32 x 3/4
#6 FLAT WASHER 2R
6-32 x 3/4 CENTER-BLOCK MOUNTING
OIL
SEE


CASCODE IF AMP
R29 47Ω
R6 22KΩ
C42 0.1µF
R9 15KΩ
R33 4.7KΩ
P50T CT
S14T CT
MHz
C6 120pF
X3
Q4 2N2222
Q5 2N2222
C39 120p
C11 40p
T3
T37-2
R13 10KΩ
R14 1.8KΩ
C15 0.1µF
C10 120pF
R7 1.5KΩ
R10 51Ω
C5 .1µF
R8 1.5KΩ
C7 0.1µF
AMP
+12
R30 47Ω
R23 2.2KΩ
R39 5.6KΩ
C43 47µF 16V
AUDIO INTER STAGE
Q6 2N2222
C31 0.01µF
C20 1µF
T4
V2 10KΩ
Q9
R40 100Ω
Q7 2N2222
10KΩ R21
R41 680Ω
R20 10KΩ
C16 .1µF
PRODUCT DET
R18 100KΩ
C32 0.01µF
R15 100KΩ
SIDETONEIN
X4 4.433MHz
V REG
+12
Q8 2N2222
BFO
+12
C17 33pF
Q13
R17 1KΩ
C18 220pF
R16 10KΩ
C19 8-40pF
R31 47Ω
D1 1N4740
C29 10µF 16V
C41 0.1µF
+10V
Co:
Title: 2N2222 RECIEVER
Board:
Revision: A
Author: S.WEBER KD1JV
Size: A
Date: 11/07/97
Sheet 1 of 1


Tx MIXER
+12V
R14
47Ω
10.7 MHz IF CANS
TUNED TO 7 MHz
C16
120pF
C9
0.01µF
T4
VFO-IN
11.5 MHz
C12
0.1µF
C3
100pF
T2 T3
C4
100pF
C5
100p
R22
100Ω
R1
39KΩ
C11
100pF
Q1
2N2222
R8
10KΩ
7MHz BAND PASS
T1
10.7Mhz IF
CAN @11.5
R2
1.8KΩ
R3
560
C13
0.01µF
Tx KEYING
1.2V KU
11.4V KD
+12V
MUTE-OUT
Q6
2N2222
+12V
R19
47Ω
C26
0.1µF
C17
10µF
R18
1.8K
X1
4.4433MHz
R6
39KΩ
Q2
2N2222
C14
0.1µF
C2
33p
C19
2.2µF
Q7
2N2222
R5
10KΩ
C1
220p
R4
1kΩ
D1
Tx BFO
LED
+12V
SIDETNOUT
+12V
C38
.01µF
R33
22KΩ
R34
3.3KΩ
R26
4.7KΩ
R27
4.7KΩ
C36
.01µF
C30
0.01µF
D3
1N4148
D4
1N4148
C37
.01µF
ToRx
C35
.01µF
C34
.01µF
Q8
2N2222
L4
100uhy
R29
5.6KΩ
R30
5.6KΩ
R31
5.6KΩ
R32
1KΩ
C39
1µF
16V
V1
10KΩ
QSK SWITCH
R28
1.8KΩ
C31
0.1µF

The receiver has a sensitivity of 0.5uv, plenty of audio to drive a small speaker, a narrow crystal filter and almost a full watt of transmit power. The rig was built for 40 meters, my favorite band.

A quick study of the schematic will show the design approach taken. The circuits used were, for the most part, shamelessly lifted intact or slightly modified versions of circuits found in the ARRL handbook and Solid State Design for the Radio Amateur. Only the exact arrangement of the basic building blocks or the exact component values used are original to me. (As is often the case with electronic design)

It is further interesting to note that few, if any, actual values were calculated. "Ball park" or example values were initially used to get the circuit "up and running" and then "tweaked" to give best performance. This is a quick and dirty way of doing a design. However, it can not insure it's reproducibility, but is a good starting point. No doubt computer modeling would produce better optimized values and insure it's reproducibility.

Since good descriptions of how the various circuits I used work can be found in the above mentioned references, I will not go into that here. Instead, I will explain why I might have chosen a particular circuit and what might have to be "tweaked" to get it to work.

First Mixer

For the first mixer, I decided to use a balanced push pull circuit, rather than a passive, diode ring, which can be hard to home-brew and get good performance.

The actual circuit used is a "clone" of the CA3028, an early differential amplifier IC. It is similar to a push pull amplifier, but has a third transistor connected to the emitters of the amplifier pair. A simple resistor could have been used, but the addition of the transistor gives a method of gain control and a place to inject the local oscillator, which gives good isolation of the LO.

Gain of the mixer is set by the trimmer V1. Simply adjust for most hiss or signal. A muting signal is injected to the wiper of V1 during transmit through D2. C14, the 100 uF cap, keeps the mixer muted for a few milliseconds after key up. This is to eliminate popping from the trailing edge of the signal after key up.

One disadvantage of the push-pull circuit is the need for center taped transformers. It is possible to make the circuit single ended, but keeping it push pull improves the overall gain of the stage. This is not too big a deal, as we can wind our own coils on toroid cores. I used small T-37 sized cores, which in turn required the use of fine wire to fit all the turns on the core. The input coil is tuned to the input frequency, 7 MHz in this case, and the output is tuned to the IF, 4.433 MHz. For those of you who just "love" to wind toroids, you will not be happy to learn the output coil uses 50 turns of #32 wire. (Center taped, of course)

Since the inductance of a toroid can't be tuned, (at least not easily) a small trimmer cap is needed to adjust the tuned circuit. Although not shown on the schematic, I used a fixed cap and a trimmer to produce the required amount of capacitance. I discovered that putting some of the capacitance from the collectors to ground, rather than across the coil, reduced a tendency of the mixer to oscillate.

IF Filter

To give the receiver a reasonable amount of selectivity, a simple crystal "ladder" filter is used. It is made of three inexpensive 4.433 MHz crystals and a few caps. 4.433 MHz happens to be the European "color burst" frequency. It is also an odd frequency, generally clear of SWB interference. No attempt was made to ideally match the input or output impedance, or to select the optimum value of the loading capacitors. "Ball park" values were used, which experience has shown to work well. Even with unmatched crystals and im-

pedance, the filter has about a 500 Hz bandwidth.

IF Amp

A cascode amplifier is used for the IF amp. This can be viewed as a common emitter amplifier driving a common base amplifier. It has very good gain and good stability. Although, with a tuned output on a densely packed board, it can oscillate. A 4.7 K resistor was added across the coil to reduce the "Q" and this eliminated the propensity to oscillate. One last note. The bias resistors, R6 and R9 on the schematic, are fairly critical in their values. They may need to be adjusted to suite the particular transistors and power supply voltage used. They are also somewhat interactive. If R6 is too small a value and R9 is to big, Q4 will saturate and there will be little, if any gain. If R9 is made smaller to compensate, Q5 will draw too much current and will get hot, although the gain will be good. A happy compromise must be found. The values shown will be a good starting point.

Product Detector and BFO

Another CA3028 "clone" type circuit is used for the product detector. A center tapped audio transformer is used for the collector output load. 0.01 uF caps from the collectors to ground by-pass the unwanted RF products. What is interesting about this circuit is the use of the current sink transistor as the BFO oscillator. This normally can't be done with the CA3028 IC, as a pull up resistor from the emitter - collector junction is needed and this connection is not available on the CA3028 IC. The actual oscillator configuration is the classic Colpitts. A tuning capacitor in series with the BFO crystal allows setting the BFO frequency above the filter center and to set the actual beat note.

Audio Amp

I desired a speaker level output. This required using a class A amplifier with a 500 W to 8 W audio output transformer. After several miss-starts, I settled on the amplifier shown. The two stage, high gain, direct coupled amplifier comes from a W7ZOI rig. I simply added an AC coupled emitter follower to drive the speaker transformer. As this amplifier is low power, it works best when driving a CW resonant speaker. (A 2" speaker pushed to the bottom of a 10 oz. plastic water tumbler works good for me)

VFO

The VFO is the most critical part of the whole rig. It must be low drift. Since an odd frequency is required and I wanted to cover most of the CW band segment, a VXO type VFO was out of the question. I was not happy with the way the common transistor VFOs worked. A search through the books turned up the "K7HFD Low noise oscillator" (1996 handbook and "Solid State Design for the Radio Amateur"). I refer you to these references for a complete description of the circuit. This is a nice simple circuit, which has the advantage of having a high level output. The disadvantage is a considerable voltage can be developed across the tuning cap, which limits the usefulness of a varicap diode for tuning. This was no big deal for me, as I much prefer to use an air variable and reduction drive anyway.

To make a low drift VFO, especially at the required frequency of 11.433 MHz, attention to the mechanical details is a must. The circuit must be built rugged, ideally in it's own shielded box. NPO and selected silver micas must be used in the tank circuit. Although a ceramic coil form would have been best, I used a T37-6 powdered iron toroid core. Once the turns had been adjusted, the wires were set with red nail polish. "Q- dope" might be a better choice if available. The circuit was built on a pc board and solidly mounted. The VFO does have significant warm up drift, but settles down nicely after about 10 minutes.

For stability, power to the VFO must be regulated. This is done with a well filtered, simple zener and pass transistor circuit, mounted out side the VFO box.

The Transmitter Section

The transmitter in this design must work opposite of the receiver. The VFO frequency has to be mixed with a BFO similar to that of the receiver to produce the final transmit frequency. As we are dealing with signals of reasonable level here, a simple single ended mixer is used.

The VFO is applied to the mixer through a 10.7 MHz IF can, tuned to 11.5 MHz. The transmit LO is a 4.433 MHz crystal oscillator. This might have been the same oscillator used in the receiver and indeed, the circuit used is virtually identical. A separate circuit was used as the transmitter was built on a separate board and this also eliminated the need to change the BFO frequency during transmit. Simply grounding the Tx BFO crystal resulted in the proper Tx offset.

The output of the mixer is connected to another 10.7 MHz IF can, padded down so it will tune to 7 MHz. This in turn drives two more IF cans connected as band pass filters, providing a good clean signal at 7 MHz. A cascode amplifier, similar to the one used in the receiver IF, but more heavily biased, is used to amplify the 7 MHz signal to about 10 mW. This is used to drive the final power amp.

TX Keying

The transmitter is keyed using two transistors. To keep the current required to be keyed low, only the bias resistors for the transmitter are keyed. The Transmitter mixer is left on all the time, so it doesn't change the loading on the VFO and cause a frequency shift. A 2.2 uF cap connected to the base of Q6 slows down the turn on time so there is some keying wave shaping. A 10 uF cap on the collector output side slows the turn off time to shape the trailing edge. Q7 is normally biased on by the pull up resistor. An LED is placed from the emitter to ground so there is about 2 volts on the base, which is pulled to ground by the Morse key. When the base is grounded, the transistor is turned off, allowing the keying transistor to turn on.

Side tone is provided by a simple phase shift oscillator. It has a frequency of about 1 kHz, but can be pulled with the output level control, V1. While keying, adjust the level control for a pleasant volume and pitch. The side tone level is independent of volume control setting.

Output Power Amp

The power amp is a single 2N2222 stage, biased class A. The biasing resistor also provides negative feedback for stability. This amplifier provides up to nearly a watt of output power. A 1 ohm resistor, unbypassed, is needed to provide thermal and RF stability. The transistor must be well heat sinked and a TO-18 metal can type used. I used a heavy duty TO-220 type heat sink. The screw mounting hole was drilled out so it would press fit over the metal can. Liberal amounts of heat sink compound was applied. I used a mylar insulator normally used with a TO-220 case, wrapped around the 2N2222 can before pressing into the heatsink. This allowed the heatsink to be grounded, as the transistor can is live. A simple one section low pass filter is used to ensure a clean output signal and cleans up the wave form into a nice looking sine wave.

T/R Switching

A diode switch is used for instant QSK. It is self powered using the rectified RF output to turn the diodes off during transmit.

Construction

"Ugly" construction was used to prototype the receiver but was moved to a proper pcb for the second pass. Now that it's really working, a final pass will be need to clean up all the mods. I really recommend this extra step as it results in a better looking, reliable and better working unit.

Conclusion

As we have seen, it is possible to build a functional rig using only 2N2222 transistors. Not only that, it can give good per-

formance. You are welcome to borrow any circuits ideas found in this design, or reproduce it as shown. I hope you have fun designing and building your very own "2N2" rig and may it give you much satisfaction.

Parts List for Receiver Schematic

C1,2,3,5,7,15,16, 23,24,25,27,42	.1uF
C4,11,12,19	8-40pF trimcap (Mouser 24AA084)
C6,8,9,10,13,14,37,39	120pF
C17	33pF
C18,28	220pF
C20	1uF
C21,43	47uF/16V Elec.
C22,29	10uF/16V Elec.
C26 ?uF[C33 = 200pF, C34 = 25pF tuning cap, C35 10pF, C36 25pF trimcap	
C30,44	100uF/16V Elect.
C31,32	.01
C38	47pF
C45	1uF/16V
D1	1N4740
D2	1N4148
FB	3 needed
L1,2	22uH
Q1,2	MPS2222
Q3-14	2N2222
R1,39	5.6K
R2,5	1.2K
R4	390
R6,23	22K
R7,8,9	1.5K
R10,24,28,38	51
R12,41	680
R13,16,20,21	10K
R14	1.8K
R15,18	100K
R17,25,32	1K
R19	150
R22	39K
R26,33	4.7K
R27,29,30,31,42	47
R34,40	100
R37	47K
T1	T37-2 28T P, 2T, 6TCT
T2	T37-2, P50T, S6T
T3	T37-2, P50T CT, S14T CT
T4	Mouser 10K CT-2K CT 42KM002
T5	Radio Shack 273-1380 1,000 ohm CT to 8 ohms
T6	FT37-43, 8TP, 4TS
T7	T37-6, 12TP tapped at 1 T, 2TS
V1	10K Volume Pot
V2	10K trimmer
X1,2,3,4	4.433MHz

Parts List for 2N2222 Rig Transmitter Schematic:

C1	220pF
C2	33pF
C3,4,5	100pF
C6,7,8,12,14,18,22, 23,24,26,31,32	.1uF
C9,13,29,37,38	.01uF mono
34,35,36	.01uF poly
C10	.001uF
C11	100pF
C16,33	120pF
C17,27	10uF/16V Elec.
C19	2.2uF/16V Elec
C20,21	470pF SM
C25	8-40 trimcap (Mouser 24AA084)
C39	1uF/16V Elec.
D1	LED
D34,5	1N4148
L1	T37-2, 15T
L2,3	FT37-43, 10T
L4	100uH
Q1-8	2N2222
R1	39K
R2,11,18,28	1.8K
R3	560
R4,10,32	1K
R5,8	10K
R6,17	39K
R7,15,29,30,31	5.6K
R9,13	51
R12	1
R14,19	47
R22	100

R25,26,27	4.7K	T4	10.7MHz. IF Can Tuned to 7.0MHz (T1-4) Mouser 42IF122
R33	22K	T5	T37-2, 38T Pri, tapped at 8T, 6T S.
R34	3.3K	T6	Ft37-43, 6T Pri, 4T Sec.
T1	10.7MHz IF Can @11.5MHz	X1	4.4433MHz
T2	10.7MHz. IF Can Tuned to 7.0MHz	V1	1K Trimpot
T3	10.7MHz. IF Can Tuned to 7.0MHz		

Building the KD1JV 2N2er

Initially, this was not going to be full fledged building article. However, Doug talked me into supplying the pcb artwork so a few building comments are in order. At this time there are no plans to offer pcb's or a kit. We'll wait until all the designs are in and the judges have a chance to pick the best ones offered. Of course, I hope mine will be a strong contender.

The rig is built on three boards, the receiver board, transmitter board and VFO board. This gives you the option of building only part the project. You will notice the boards are fairly small and densely packed. This was something of a rush job to get done in time for publication. I haven't had a chance to build and test these "clean up" layouts. Therefore, I can not guarantee that there are no errors in the track placement or component numbering. However, if there are any errors, they should be minor ones.

Note that the artwork is a through-board or x-ray view. This is so you can directly copy the layout onto toner transfer film, without the extra step of first making a transparency copy to "flip". Speaking of toner transfer film, I strongly recommend using the Techniks "PnP Blue" film. Although TEC200 film is okay, the PnP Blue is "the best". (It can be ordered from All Electronics)

You can use either double or single sided pcb stock. I generally use the double sided stuff. The VFO should be a single sided or the copper removed around the coil. If you use double sided material for the Rx and Tx boards, space the toriod tuned circuits about 1/8" above the copper to prevent it from affecting the coil tuning. A small amount of silicon "goop" could be used to hold them in place above the board. Don't forget to connect the top ground plane to the bottom ground in several places around the board. The parts list and schematic show the use of T37-2 cores. The board is laid out so that T50 sized cores can also be used. If you use the T50-2 cores, simply reduce the number of turns on the primary or tuned side of the coil by 4 or 5 turns. When installing the transistors on the boards, note you may have to bend the center base lead either towards the flat side or away from it for the flat on the transistor to match the flat on the layout drawing. Electrolytic capacitors have a circle marked on the negative lead and a "+" on the positive end.

Radio Shack #273-1380, 1K to 8 Ohm audio transformers maybe used on the Rx board in both locations. However, if you have or can easily get an interstage transformer with a higher secondary impedance, for the product detector output, it most likely will work better. Note that the speaker output transformer slightly overhangs the edge of the board. The speaker output wires can be tacked to the pads under the transformer or wired directly to the speaker jack.

A good way to connect wires to the boards is to use SIP header pins. Snip them off the strip and insert in the wire connection holes. This makes a neater and more solid connection, than simply connecting the wire to the pcb copper pad.

VFO

The VFO board is laid out so TO-18 case transistors can be used. Not having a good place to put the voltage regulator, I

put it on the VFO board. For a tuning cap, an air variable and reduction drive is strongly recommended. Hopefully, you have something suitable in the junk box or can find one at a Hamfest. A small "APC" type would work fine. Small reduction drives can still be had from Mouser.

If you have a ceramic coil form, this could be substituted for the toriod. There might be enough room to drill a mounting hole for the ceramic form where the toriod goes. Provisions for varicap RIT tuning are provided on the board, but is not shown on the schematic. With some experimentation, it could be possible to use the varicap to tune the VFO, rather than the air cap.

Packaging

I built my rig into an old CB "Slider" VFO box. It is a nice size, about a 6" cube and has a very nice silver plated tuning cap, two speed reduction drive and dial. (Channel 21 turns out to be 7.040 MHz) The Radio Shack 270-253 box should also work well (Boy, those are getting expensive). In this case I would mount the Rx and Tx boards on opposite sides of a metal bracket and stand them up vertical. Just make sure you wire it up so there is enough wire slack to fold the boards out of the box for service or adjustments. You will most likely have to stiffen up the front panel when mounting a tuning cap to it.

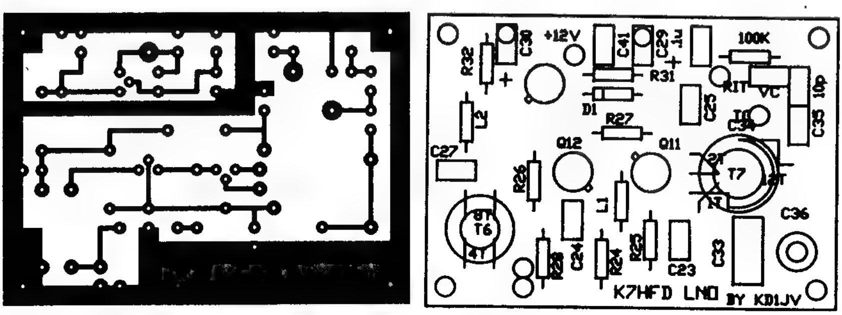
The connections for the key and side tone are fairly close to the transmitter low pass filter. I would recommend using small shielded wire here and route the wires so they go up and away from the coil. Don't forget to build some kind of heat sink for the PA output transistor.

Options.

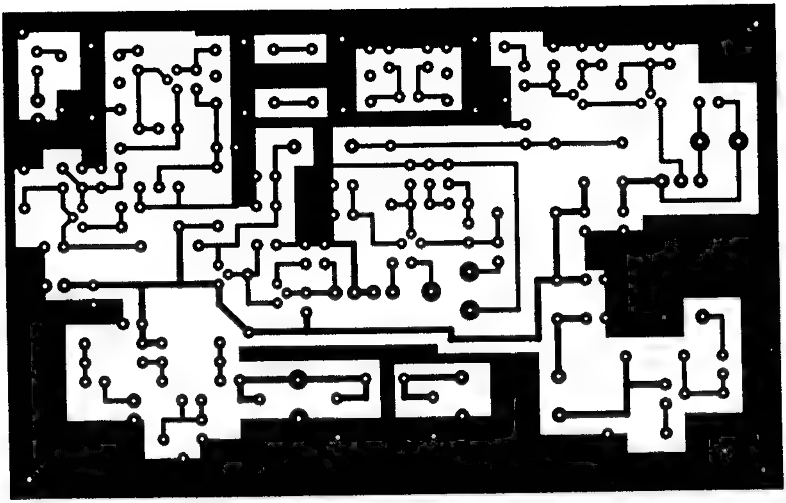
RIT is the most handy thing to add. As noted above, provisions are made for it on the VFO board. The only problem is switching out the RIT control during transmit. I can't think of a good way to do this with an NPN, so I plan on making a concession to reality and use a 2N4000 type mosfet.

A front panel gain control can be added. Use a resistor in series with the wiper and connect it to the V1, R12, D2, C44 junction on the Rx board. A hole is provided on the board for this. The resistor should be in the 10K to 47K range. Choose a resistor value that will give you the best adjustment range of the gain.

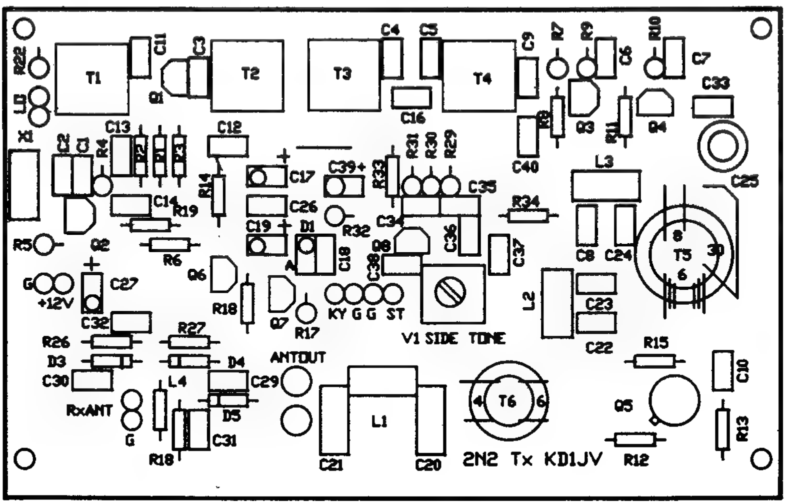
There is no reason this rig couldn't be built for other bands. 30 meters would be easy, and you could still use the 10.7 MHz IF transformers in the transmitter sections. Other bands would be a little harder, as you would need to make your own transformers by reworking the 10.7 MHz cans or using a suitable TOKO coil.



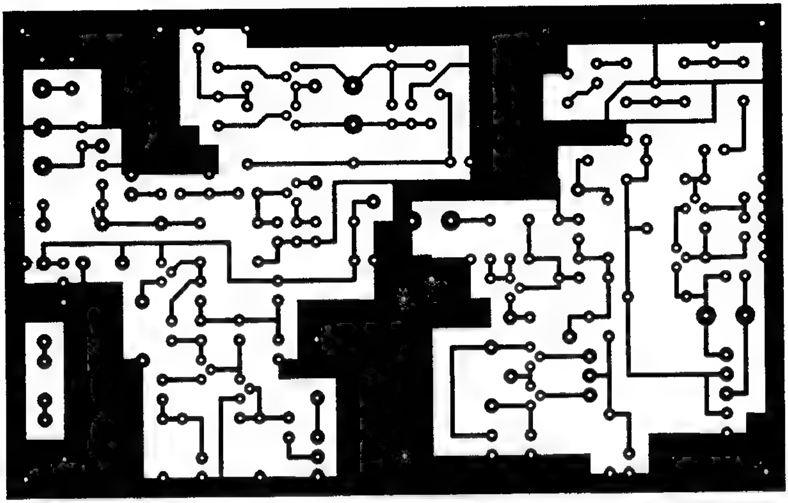
2N2222 Transceiver VFO Board and Parts Overlay, Xray View



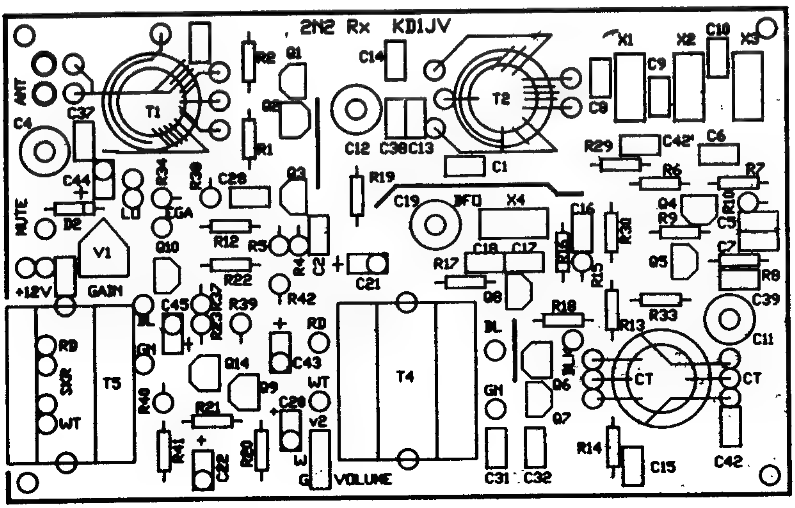
Transmitter Board (XRay View from Component Side), 2N2222 Transceiver



Transmitter Board Parts Overlay, 2N2222 Transceiver



Receiver Board (Xray view from Component Side), 2N2222 Transceiver



Parts Overlay, Receiver Board, 2N2222 Transceiver

The K8FF Paddle

by Wayne Smith, K8FF
19121 Cascade Ct.
Aurora, OH 44202

[Note: Drawings and diagrams are in the centerfold section of this issue.]

Last year while driving home from the Dayton Hamvention, I began to think of all those neat and useful gadgets that had caught my eye. Since my favorite mode is CW, keys and paddles are always interesting to me. The feel of the Vibroplex magnetic paddle was just too good to ignore. I began to engineer a simple design without the use of any complicateed or difficult to duplicate parts. My goal was to make it simple without loss of that smooth magnetic feel.

This design can be built without fancy machine shop type tools but care must be taken in the layout and actual metal cutting operations. The construction can be accomplished with a hand drill and a hacksaw. Construction is easier and more accurate if a drill press and a belt sander are available.

The cost of the materials is just a few dollars so why not give it a try? Dust off your tools and recall fond memories of your high school shop class and in just a few hours you will have a paddle "to brag about".

Begin by cutting all material to size according to the drawings. You will find it easier to avoid mistakes if you cut the brass stock slightly larger than required and then sand or file to size. Use a scribe and a center punch during layout for accuracy. Drill smaller holes first then follow with the correct size to minmize errors. For simplicity, all tapped holes are 6-32 thread except for the 4-40 holes in the contact posts. Remember to use light oil when tapping. After everything is cut, drilled and tapped, then the fun begins.

Let your imagination run wild. Brass can be polished or satin finished with WD-40 and 400 grit sandpaper. The base can be chromed, painted or even gold plated!! Old relays can become contact donors. The more carefully you follow the dimensions, the better the results.

Hints and Suggestions:

A. Since the base is made of heavy and hard to cut steel, when purchasing it try to have the metal dealer cut it to size. They usually are glad to make cuts for a nominal sum. When laying out the holes, use a scribe and center punch before attempting any drilling. Begin by drilling a small hole first then follow with the correct size. Don't be afraid to file and sand to remove any sharp corners or scratches that will show through the paint.

B. The magnet block should be spaced up away from the base in order to aligh the contacts and the magnet properly. This is accomplished by drilling out the threads from two 6-32 brassnuts and using them as spacers under the magnet block. The alarm magnets are slightly larger than 1/4 inch so you must press them into a 1/4 inch hole. This can be done slowly in the jaws of a vise. Magnets are difficult to cut to size, 1/2 inch long. The best way is to break them slightly longer and grind to size, or use a cutoff saw. This can be done with a vise and hammer then either a bench grinder or a hand held grinder will work if the magnet is held in the vise.

C. Try to make the arms match in size and appearance. this will add to the balance that you are looking for. Take care when tapping holes so that they are square to the surface. This will ease the assembly and improve the accuracy of the project. If possible ream the 1/4 inch pivot holes to improve the bearing action of the aluminum spacers. If after the spacers arecut to length they seem tight in the holes, try buffing the spacer on a buffing wheel or a dremel tool. This reduces the size slowly

and provides a smooth bearing surface. Use two #6 brass washers below each assembly to provide clearance for the arm above the base.

D. Cut the plexiglass slightly larger than the drawing and sand or file to size. You may want to contour the corners for comfort also. After drilling and cutting, remove the protective paper from the surfaces and polish to a diamond like luster. Size and overall shape can be changed to suit personal tastes also.

E. If insulating washers are not available use notebook hole reinforcing rings on both sides of the base and shring tubing over the screw threads, but watch the alignment of the contacts. Washers can be used to align the contacts correctly. Contact posts can be made of either round or square 3/8" brass stock. Square is much easer to drill accurately.

I hope you build and enjoy the paddles. 72, Wayne, K8FF

Materials List:

8" of 3/8 inch square brass bar stock
1 - 2 3/8" x 3" x 1/2" steel bar stock
1 - 4" x 4" x 3/16" Plexiglass or Acrylic
1 - 1/4" x 1" round magnet
2 - 1/4" diameter 3/8" aluminum spacer
or
2 - 1/4" x 3/8" bronze bushings
4 - Stick on rubber feet
4 - Fiber washers Mouser #534-3233
2 - 4-40 x 3/4 SS Socket Head Screws
2 - 4-40 brass nuts
8 - 6-32 brass nuts
2 - 6-32 x 3/4 Socket Head Screws
3 - 6-32 x 3/4 Screws
1 - 6-32 x 7/8 Screw
4 - 6-32 x 3/8 Screws
4 - #6 Brass Washers
2 - 6-32 Set screws
2 - 6-32 SS Set screws
3 - #6 Solder lugs
1 - 1/8" Cable Clamp

[Editors Note: Wayne's design was the winner of the 1997 NorCal Design Contest and NorCal has kitted the K8FF Paddles. Complete kits are available from Jim Cates for $30 plus $5 shipping and handling in the US & Canada, $10 shipping and handling for the Europe and South America, and $15 for the Australia, New Zealand and the Pacific Rim countries. The kit consists of all parts, hardware and base. The machined parts are NOT finished, but can be easily done by hand. There is a comprehensive 4 page manual included.

Send your checks and money orders made out to Jim Cates, NOT NorCal, to:

Jim Cates
3241 Eastwood Rd.
Sacramento, CA 95821
USA

Pacificon Report from N2APB

by George Heron, N2APB
g.heron@dialogic.com
http://www.njqrp.org

I'm sitting here at 35K feet on the way back from the NorCal-sponsored QRP forum at Pacificon this weekend, and still have a glow from listening yesterday to the *fabulous* lineup of speakers and topics. I've never before seen such a powerful and relevant agenda of topics for the QRP community.

Many of you already know about the major components of the Pacificon QRP Forum from the near-simultaneous NorCal website pictures and postings, as well as from those quicker to the email connection than I, but I thought I'd give a rundown of everything from my "NJ-QRP perspective". Here's a listing of the topics I'll be covering in this article:

1) Pacificon: The Big Picture
2) Unveiling of the NorCal Secret Project: QRP Paddles

3) Great TiCK Presentation by Gary Diana and Brad Mitchell
4) Superb Computer-Controlled Rig Design Overview by Dave Benson
5) Roy Lewallen's Stories of Field Operation
6) Dave Gauding's Overview of Stealth Antennas
7) "EleCraft" Formation by Wayne Burdick and Eric Swartz: Rebirth of the Heathkit Era"
8) NorCal's Hospitality Suite & the Construction Judging
9) SweepStakes Contesting Tutorial by K5FO and KU7Y
10) California "Ham(s) of the Year" Awarded to Doug Hendricks and Jim Cates!
11) Wonderful Dinner Spent with the AZ ScQRPions
12) Informal Discussions with KI6DS, KI6SN, KE6RIE and KA5DVS/6

Okay, there's a lot to cover, so let's get into it!

1) Pacificon: The Big Picture

The overall conference is 3-day event sponsored by the Mt Diablo ARC. There was a mini swap-meet, an exhibit hall for many suppliers to show their products and services, and a broad spectrum of ham-related presentations, including a presence by the ARRL. Saturday's QRP Forum, sponsored totally by NorCal, was held in a room filled to capacity with standing room only ... I estimate 150 QRPers were in attendance at each session. Jerry Parker had an electronic camera set up and connected to his computer off to the side where he was busy editing NorCal webpage updates and posting the pictures within about 5 minutes of every presenter, notable information slide and cool show 'n tell item. I hope to get a glimpse of this "near simulcast" when I plug into the Internet upon landing tonight! (If you look closely you may see me in there someplace, as there were a couple of shots of the audience during the day.) At the beginning of the forum, Doug Hendricks gave a gracious introduction of some of the celebrities in attendance and he kindly mentioned my presence "all the way from the NJ-QRP Club"! We were on our own for meals and in-between-session time, which left great opportunity for wandering the exhibit hall and chatting with fellow QRPers. The $5 admission fee to Pacificon was an absolute STEAL compared to the value obtained from attendance. Hats off to the Mt Diablo club for setting the whole thing up too, and I'll definitely try to arrange my schedule for attendance again next year.

2) Unveiling of the NorCal Secret Project: QRP Paddles

The NorCal "Secret Project" was, in addition to the fabulous lineup of speakers, THE most looked-forward to event of the QRP Forum. As I'm sure everyone now knows, the winner of the 1997 NorCal Design Contest is a QRP Iambic Paddle design by Wayne Smith K8FF. The paddles are made from 3/8" square brass stock, and are mounted on a base of steel that is 3" x 2.5" x 1/2". This design was spotted by Doug Hendricks back at Dayton, and he had to convince Wayne to submit it as a design entry, while enlisting Paul Harden to illustrate the manual, enlisting the machine shop facilities of Doug Hauff KE6RIE to actually produce the components. Over 200 paddle kits, each selling for $30, were brought to Pacificon and were sold out within an hour.

For those of you who gave me your up-front orders, rest assured that I was able to get them and I'm lugging them home right now (although the airline captain has complained about an imbalance in the weight distribution in the plane, probably due to my suitcase in the overhead bin ... the bases of the paddles are very nice and heavy.

There were several assembled and finished prototypes available for viewing and tryout ... unbelievable quality!!! These paddles put my Bencher to shame and will

become a permanent fixture in both my base and portable station. For the first time we can all have an absolutely complete, quality construction homebrew station.

The unassembled and partially-finished kit has a wonderfully clear assembly and alignment manual, and describes a number of ways to finish and paint the steel base and to polish the brass posts and arms. A whole variety of customization options are at our disposal, including different color bases (and painting/finishing techniques), different smoothing and rounding of corners, brass callsign plates, built-in microkeyers, plexiglass enclosures, etc. And in fact there's already a finishing option (available from kit machinist Doug Hauff) to produce a powder-baked-on finish that looks simply outstanding ... KI6DS has a bright red one of these, and boy does it look sharp with the brightly polished brass arms and posts! The sky is the limit! I'm sure we'll be seeing more about this now-revealed Secret Project on the NorCal web pages and hearing about finishing options on QRP-L, but trust me, if you operate CW or if you've even *thought* of doing it, you've GOT to get yourself one of these paddles.

3) Great TiCK Presentation by Gary Diana and Brad Mitchell

Brad and Gary, of Embedded Research fame up in Rochester NY, gave a great 2-part presentation: the history of keyer electronics, a la the famous John Curtis designs; and an in-depth look into the TiCK design utilizing the PIC microcontroller. Brad's overview of the keyer evolution really illustrated Curtis' cleverness and ingenuity leading up to the famous 8044ABM chip, which is no longer in production. (WA6GER allegedly has a few left!). Gary's "cookbook" overview to designing projects using the Microchip PIC family of components provided some great leads for hams in the audience looking to get into this exploding area of digital control for amateur radio applications.

4) Superb Computer-Controlled Rig Design Overview by Dave Benson NN1G

In my opinion, this was the highlight of the presentations over the entire day. Dave continued and extended the discussions of PIC-based microntrolled rig design with an actual breakdown and walk-through of a forthcoming rig from his Small Wonder Lab. Detailed information gave wonderful insight and many good design tips as to how to accomplish microcontroller-based frequency measurement, Huff 'n Puff control of a VFO, and various other aspects of rig design with a DDS chip. One of the Q&A interactions fully explained the related problems with the TenTec rig noted on QRP-L. Dave had an operational prototype of his QRP transceiver design based around these concepts ... stay tuned for news of availability later this year.

5) Roy Lewallen's Stories of Field Operation

The King of Field Operations gave a talk similar to what he had done at Dayton, and was as entertaining as ever! Roy gave us a run-down of items he carries out to his Field Day outings up in the high Oregon mountains: a keyer, the Optimized Transceiver (40m), transmatch, directional wattmeter, 1/4 dipole (with reasoning and data to show it's just about as effective as 1/2 wave versions), 1 band/spool of wire with BNC connectors for the feedpoint, notation that plastic feedpoint insulators degrade fast in sunlight, a solar cell array for daytime power and an HT 12v battery for night operation, a slingshot with 3 oz weights with 6 lb fluorescent fishing line plus nylon twine for feeding the trees, headphones, a 5W "brickette" amp, connecting cables & tools (esp. a butane soldering iron), a small spdt switch box for A/B antennas switching, log book, pencil, coat and hat .... all contained inside a small case about 12" x 5" x 6" !! Roy's stories and pictures of mountain top operation since

the '60s (he had a picture of Mt St Helen *before* it blew!) was cut a bit short due to some room scheduling snafu, but it sure was great listening to the Master!

6) Dave Gauding Overview of Stealth Antennas

Dave had a nice presentation overviewing various cliff-dweller (apartment and condo) antennas and his trial-and-error methods of refinement over the years. His stories and pictures were great (again, hope there are some follow-up notes published!), and he focused on: slinky antennas; the "Aluminum Cloud" (73 Mag for '94); an antenna by Llyle Lovell in 9/86 of 73 Mag; a stealth whip pointing out the window; a "Distributed Capacity Twisted Loop" reviewed in QRP-L Dec 27, 1995 by Bob Follett and in CQ for 9/94 and 73 for 10/94; an on-the-ground "beam" called the SGA reviewed by W4NVK in 10/69 of 73 Mag; and a 33-1/2' vertical aluminum vertical reviewed in 73 for 1/95. BTW, Dave's St Louis QRP Club is renowned for getting out over 120 consecutive months of their newsletters!

7) "EleCraft" Formation by Wayne Burdick and Eric Swartz: Rebirth of the Heathkit Era"

Another "big" announcement/unveiling this weekend was the founding of a new company called EleCraft, by Wayne Burdick and Eric Swartz. Structured to fill the gap left by Heathkit's demise a number of years ago, Wayne and Eric have teamed up to extend their design collaboration beyond the successes of the Sierra, 49er, KC-1 and KC-2, et al, toward a new 9-band, high performance, CW/SSB, computer-controlled modular transceiver kit called the "K2". Some appropriate humor-filled background was provided on selection of the name (not another mountain range, but .... They currently have mock-ups of the K2 and it looks quite impressive, with features that will knock your socks off! They are currently soliciting for feature/functionality input from people and plan to get some prototype available early next year (I think.) You can find more details and pictures at their website: http://www.elecraft.com.

8) NorCal's Hospitality Suite & the Construction Judging

Well, this was yet another exciting part of the entire weekend ... never before have I seen an array of so many incredible construction projects in person, under one roof. The idea was that all of us QRPers should bring our latest construction project and enter them anonymously (i.e., without distinctive labeling) for a "judging" to be done by K5FO and cohorts -- there were keyers in stapler guns, compact HF antennas, completely homebrew and modular multi-band transceivers, transmatches, packaged kits, you name it! I can't recall all the winners of this thing (boy, that sure had to be a hard job), but I entered my suite of 4 small dual-blue boxes containing my 38s, Rainbow Tuner, Galbraith Paddles and Battery Pack and won an "honorable mention".

9) SweepStakes Contesting Tutorial by K5FO and KU7Y

Chuck Adams and Monte Stark hosted a real informative session after the Construction Judging wherein they demonstrated some basic and good contesting practices with some almost-live" equipment. Chuck emphasized and amplified many of these practices and cautions in preparation for the powerhouse SweepStakes contest coming up on the weekend of Nov 1. During SS, there will be 24 hours of operating (with a 30 hour window) with lots of fast ops. We'll sure have a run for it in the Q (QRP) category, and Monte & Chuck gave us all sorts of pointers (who calls whom, use of a computer with logger software, pacing oneself, etc.) The two guys played caller/callee several times to illustrate their points. Pretty good stuff.

10) California "Ham(s) of the Year"

Awarded to Doug Hendricks and Jim Cates!

This news was an even better-held secret than that of the NorCal project! Chuck Adams had approached the ARRL during their solicitation for this award earlier in the year, and found more than ample evidence substantiating the recommendation. Doug and Jim were both surprised and honored to the point of embarrassment ... certainly no two better recipients of such an award. I believe the official announcement/presentation will happen soon from ARRL.

11) Wonderful Dinner Spent with the AZ ScQRPions

I had an informal dinner with a group of ScQRPions Saturday night . Perhaps my hungry, drawn and conspicuously out-of-place east coast paleness caught their sympathy and they graciously invited me along. Actually Dave Benson was also along for the dinner so perhaps the east coast aura was detected there too. I'm now proud to say that I'm an honorary ScQRPion since that dinner. (No, they didn't make me pick up the bill, although Joe Gervais tried desperately to do something like that.) They sure have a great group and are modeled somewhat along the lines of our own NJ-QRP ... nothing too official, just getting together primarily for operating -- and what operating they do! I heard all sorts of stories upon which we'll have to model our own outings.

12) Informal Discussions with KI6SN, and KE6RIE

I also met up with Richard Fisher KI6SN, famous column editor of World Radio (did a *great* review for our Rainbow Tuner in last July's issue) and board Member's News columnist for ARCI. We had some very pleasant discussions of backgrounds (found out we have overlapping geographic pasts here in NJ ... Morristown) and discussion of his wonderfully-done Z-Match Tuner he submitted for Saturday night's judging. IMHO he should've taken one of the awards that evening. Hope to get some pictures of it to put alongside Dave Maliniak's version on our website.

I spent more than a few minutes chatting with Doug Hauff, KE6RIE about the forthcoming Rainbow Tuner enclosures he's doing for the QRP community. You'll recall that he's the excellent machinist and company called San Louis Machining who provided the bullet proof anodized enclosures for the 38s (you can still get those too. Visit and drool at: http://www.fix.net/~slmachco/), AND the guy who's responsible for providing the machining for the new NorCal paddles project. This is one busy guy who deserves TONS of thanks from our QRP circles. Doug is excited about the Rainbow enclosures coming along soon, especially because he received some pretty big billing in the recent Dave Ingram article in this month's CQ magazine ... right alongside the NJ-QRP Club with Joe's Rainbow design!! (Check out the article, great stuff!)

Well, that's about it from me about Pacificon. Sorry for the length of this but I thought you all would enjoy hearing about my perspective on things. I was treated with overwhelming hospitality by everyone I encountered this weekend, being one of the few QRP "emissaries" from back east. I was able to put some new faces to the names and calls only previously encountered on the air or on email, and was able to make a few new friendships I hope will last for a long time to come. 72, -- George Heron, N2APB

Message Recorder-Keyer

by Floyd E. Carter, K6BSU
2029 Crist Dr.
Los Altos, CA 94024

Here's a message keyer that willtransmit yourpersonal message or contest call at the touch of a button. Memory keyers which can do that are common with contest operators. The current crop of memory keyers all have a drawback. They all transmit perfect Morse, and not the kind of CW that most people send! How about CW operators who use mechanical bugs, or who are reasonably good with a straight key? How about sending your calling message in your own fist?

The Message Recorder-Keyer is a handy device which will record your CW message up to 20 seconds, and then play it back exactly as you recorded it, with your own "swing" or other personal sending defects! During playback, the circuit will automatically key your transmitter in CW mode.

If you connect the audio output of your receiver to the Message Recorder-Keyer input, you can record any receiver output, either voice or CW. This is handy for DX work, when the DX station seldom sends his own call, and the staions working the DX will not send it either. So each time the DX comes back, record his brief transmission. If a callsign is included, you can play it back repeatedly to make sure you have it down correctly. (You have to disconnect the keyline to your transmitter or else it will try to key your transmitter each time you listen to the playback.)

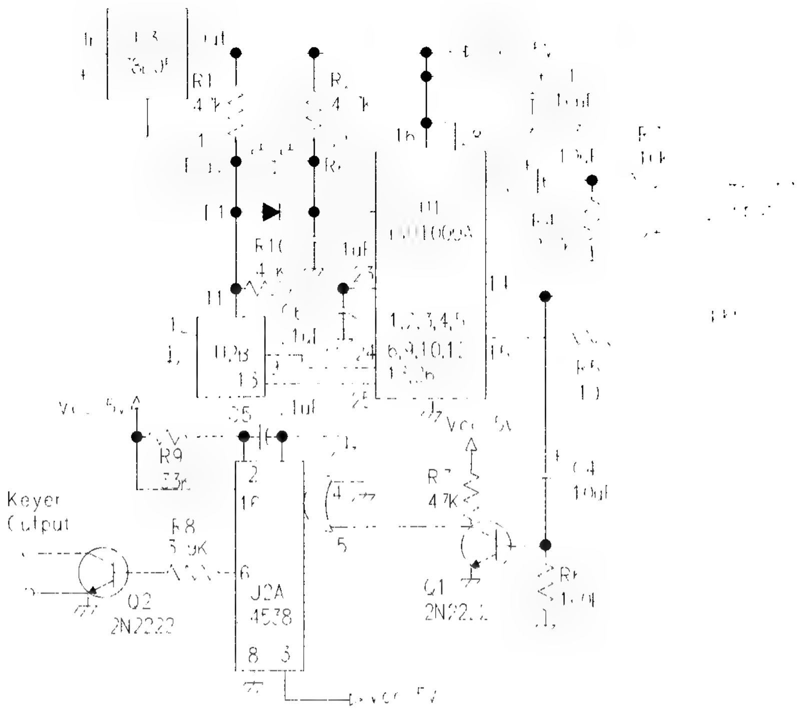
The Message Recorder-Keyer ;is designed around an interesting 28-pin chip form Radio Shack. When used as a CW keyer, the chip records the sidetone output of your transmitter or a code practice oscillator. Because it plays back exactly the CW tone recorded, the audio output must be "rectified" by a Monostable Multivibrator set to re-trigger on each peak of the audio tone. The result is a keyline to your transmitter, with a loudspeaker output thrown in for good measure.

Operation is simple. Connect your transmitter sidetone monitor, code oscillator, or receiver output with about 1 volt RMS to the "Record In" and record up to 20 seconds while holding down the "Record" button. Releasing the Record button at any time terminates the recording function and sets an end-of-message marker. Connect the Message Recorder-Keyer keyline output to your transmitter and momentarily press the "Play" button. Your CW message will key your transmitter exactly as you recorded it, warts and all. The built-in loudspeaker lets you monitor the playback.

Circuit Notes:

For the digitally enhanced reader, here is how it works. The Radio Shack chip comes with complete instructions and description, so I will not repeat them here. Think of it as a variable-length audio tape loop. U2A is set to generate a pulse of 0.0033 sec, but its output is continuoulsy retriggered by each peak of the playback audio tone, as long as the tone is above 303 Hz. So U2A operates like a digital rectifier, converting audio to key closure. U2B is the other monostable multivibrator in the IC, but it is connected to act like an R-S flip flop. IT puts the unit into a "sleep" mode for almost zero power consumption between uses. Memory is not erased with power off, so your recording will remain until the old message is recorded over by a new message.

The RadioShack chip is designed for 5 volts. A 78L05 +5 volt regulator is shown so input power can be anything from 5 to 15 volts DC. Current consumption at 5 Volsts is 25 mA during Record or Play. If a speaker is connected, expect the



K6BSU Message Recorder

current to peak at about 75 mA. During standby, the "sleep" mode reduces current drain to 10 uA.

The prototype unit was built on single sided PC board material, using point-to-point wiring. S1 and S2 were epoxied to the circuit board, but the switches may be brought out to a front panel, if desired.

Parts List:

U1 ISD1000A (RS #275-1325)
U2 CD4538A Dual Mono Multivibrator IC
U3 78L05 5 Volt 3-terminal regulator
Q1, 2 2N2222 or 2N4401
C1,3,4 10uF Elec. 10V or higher
C2,5 0.1 disc or mono cap
D1 1N4148 silicon diode
SP1 8 ohm speaker, 2" diam.
S1,2 SPST N.O. PB switch
All resistors 1/4W 5%

4 WATTS FROM YOUR GM-10 (and other mods)

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I ordered a 10-meter version of the Green Mountain transceiver family from Dave Benson at Small Wonder Labs in anticipation of improved propagation on the ten-meter band. As usual, Dave did a fine job on the manual and the kit packing. Controls connect to the board by plugs and headers. I bought a Ten-Tec TP-41 case which just fits the board nicely. I continue to be very-favorably impressed by the fre-

quency stability of my GM-10. I was also pleasantly surprised by the high quality of the filter crystals supplied with the kit. My goal in making modifications was to obtain at least 2W output, but along the way I made a few others, too! Here's what I did and why:

1) The stock tuning range of my rig was 77kHz. I changed C19 to 56pF and got a 99kHz range, nearly perfect for my 10-turn pot and counter dial.

2) It was hard to believe the warm-up stability of the 20MHz heterodyne chain. From a cold start, the frequency increased 9Hz after 1 minute. Thereafter, it slowly decreased back to the starting value over a 10 minute period.

3) Tuning C45 gave only one peak. Near-resonance was at minimum capacitance. Removing one turn from L7 solved the problem. Then I got two peaks, and could tune smoothly through each one.

4) I had the same problem and results with C40 and L6.

5) I replaced T2 with 14 turns tapped at 4T on an FT37-61 core. The tap is 4T up from the (+) pad and goes to the PA blocker cap. This change increased the power from 1.5W to 1.75W. (This is a conventional auto-transformer.) No traces need be cut. Three of the existing four holes are used. The left-end lead goes in the pad nearest the silkscreened word "KEY". The right-hand lead goes in the pad nearset the "+" silk-screened symbol for the 47uF capacitor. The tap is 4T up from the left-end lead, and goes in the other pad facing the capacitor.

6) Replacing the 470-Ohm source resistor for Q4 with 330 Ohms brought the power up to 1.9W.

7) Replacing Q4 with another brand (giant "F" symbol) got the power up to 2.0W with a 13.6V supply. I got 1.6W using a gel cell.

8) L11 was near self resonance. I replaced it with 11T on an FT37-67 core. Tuning became sharper, indicating a higher-Q circuit.

9) Before I installed the crystals I decided I wanted a narrower filter passband. I had built Doug DeMaw's crystal checker a couple of years back, so proceeded to measure each crystal. I calculated the parameters as: Lm=0.020H, Rs= 9.88 Ohms, Fo=7.998300MHz, delta F=871Hz, and Qu=102,200. Modeling the filter on Wes Hayward's G87 program gave a -6dB bandwidth of 2.4kHz and 2dB insertion loss. This was a great SSB filter, but not what I wanted for CW! So I proceeded to design a narrow-band filter with the same circuit.

My final design models as 480Hz BW @ -6dB, 6dB insertion loss, and12dB return loss. As built, the filter is a little narrower with a nice flat top. The skirts are not as steep as NorCal 40A or Sierra filters (5MHz crystals), but I expected that, given the 8MHz crystal frequency.

Coupling caps are all 560pF monos. L-network inductors are 5.6uH (Mouser 43LS566, Q=70). Total design capacitance for each L network is 68.2pF. Differing stray capacitances resulted in 62pF for C8 and 56pF for C14. Since the MC1350 input resistance is 3000 Ohms, I changed the shunt load from pin 6 to pin 4 to 3000 Ohms to make RL= 1500 Ohms for the filter. I also mounted RFC2 horizontally to reduce any input-to-output coupling to RFC1.

10) My new filter passband was too low for the BFO oscillator, which I measured as 8.001683MHz. Replacing C15A with an inductor made of 13T on an FT37-61 core resulted in a 625Hz tone at the center of the passband for a CW signal.

11) In order to bring down the TX frequency to a matching 625Hz offset I had to change C37 to 33pF and change RFC3 to 12uH (Mouser 43LS125). Changing C37 also increased the power to 2.1W.

12) Initially, I used 110pF, 220pF, and 110pF silver-mica caps for C46, C47, and C48. The inductors were each 9T on T30-

6 cores. This was a pure half-wave filter per my article in Sept. 1995 QRPp. Later, I designed an elliptical output filter with a big notch centered on TV channel 2, just to avoid any possible TVI. If you wish to use this filter, make the following changes:

C46 = 68pF

C47 = 180pF

C48 = 91pF

L9, L10 = 8T on T30-6 core, and add a 36pF cap across each inductor (L9 & L10).

C46 is low because Q7 adds about 7pF (via an output transformer described later) and C49 adds about 19pF.

13) At 20MHz, 0.01uF caps are fine for the various bypass and coupling spots in the heterodyne chain. The 0.1uF caps used to bypass L8 and couple Q7 to the output filter are NOT good at 28MHz. They look like inductors, since their self resonance is below 28MHz. I used 0.001uF disk caps for C6, U1 pin 2 to ground, pin 8 of U7 to ground, pin 2 of U7 to ground, collector of U6 to ground, cap off R1, Q7 collector to C46, L8 bypass, and the (+) supply side of FB1 to ground. These 0.001uF caps have very low reactance at 28MHz.

14) I don't like the positions of the toroidal-inductor mounting holes. Instead of having the two holes directly opposite each other, staggering them would have two benefits. First, mounting would be easier because the holes would be right where the wires peel off the core. Second, the start and finish turns would be farther apart, reducing shunt capacitance.

15) Replacing Q7 with an ECG-341 (MRF-237 equivalent) brought the output power up to 2.6W.

16) I substituted another autotransformer for L8, using 13T tapped at 9T on an FT37-67 core. The output power went up to 3.2W. To do this mod some trace cutting has to be done. Here are details:

The "island" of copper plating (on the underside of the board) that connects to the collector of Q7 must be cut in such a way that only D11 is left connected to the collector. This means isolating the output-coupling capacitor pad and the pad used for the original connection of L8 to the collector. These two pads must be isolated on one new "island" by cutting a narrow gap in the original "island". See Fig.1 and Fig.2. Drill a wire-size hole in the remaining collector "island" where shown in Fig.1. Solder the tap lead in that hole. The tap is 4 turns up from the end lead that goes in the hole nearest Q7.

17) Next, the Q7 base-to-ground resistor was changed to 10 Ohms to load T2 better on the negative half cycles, and to "swamp" the load on positive half cycles.

18) For additional bypassing below 10MHz, I added 0.1uF mono caps to ground from the cold end of L8, the collector of Q6, and pin 8 of U7.

19) D11 was replaced with a 36-Volt device (1N4753A), and the 1M resistor at "AF SWITCH" was changed to 1.5M, both to accomodate the higher output power.

At this point I had 4W output with a 13.6V supply. This was double the power of my original goal, but I decided to try to get 4W output using a gel cell.

The input of Q7, when base driven, looks like a capacitor of about 670pF in series with a resistor of about 2 Ohms (at 28MHz). A shunt inductor from the base to emitter pads makes a nice "L" network with the input capacitance to raise the 2-Ohm load up to a more reasonable value of about 16 Ohms for T2. An optimum inductor consists of 6T of #24 wire on a T25-6 core. Adding such an inductor brought the power up to 4.9W with a 13.6V supply, or 4W with a gel cell. At 4.9W, total current drawn was 645mA, for an overall efficiency of 56%. At 4W, (12.44V from a gel cell) total current was 576mA, giving the same efficiency. Because of the small heat sink/radiator, the key-down time should be limited to 3 seconds at these power levels. Allow some

cooling time before another 3-second, key-down transmission.

Well, there you have it, my complete list of mods for the GM-10. Now all I have to add is a KC-1 keyer/counter! 72, Dave, W6EMD

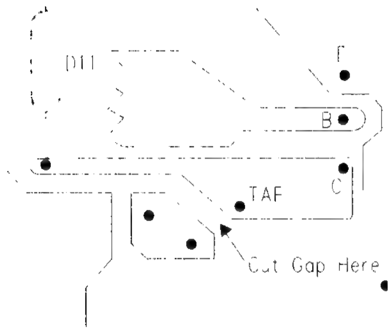

Fig. 1

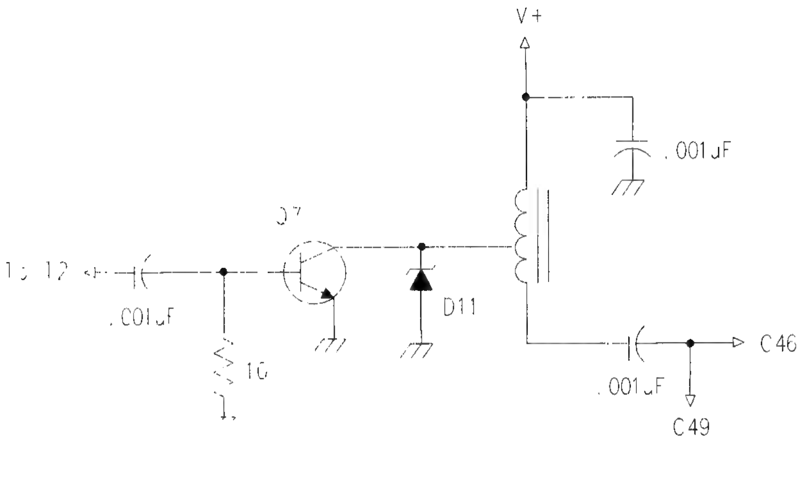

Fig. 2

Adding CW to the Epiphyte

by Graham F Firth G3MFJ/AB7VN
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Last year George Dobbs G3RJV asked for volunteers to build sample Epiphyte 80m SSB Transceivers to send with the kits under the Norcal/G-QRP scheme for the third world. Tony (G4WIF) and I offered our services and were accepted.

I built the kit & was impressed with the rig - 5 watts pep and it tuned all the UK band 3.6 to 3.8MHz. Derry VE6CB had sure done a great design job. I then thought back to Dayton last year where I had bought all sorts of things (as you do there!) and remembered that one of the things I had bought was an Epiphyte PCB from Far. So out it came & I built my second - this time, I had to get all the parts myself - well I got two lots, as Tony had bought a board as well!

So I built my second, and this worked fine as well. Tony hasn't finished his yet!! - Still!

Now, last December, Tony & I decided to have a joint boating holiday with our families on the Norfolk Broads (These are interconnected shallow lakes formed from flooded 16th century peat diggings in Eastern England). We decided to take a rig so we decided we'd take the Epiphyte but it was a shame it was SSB only. This got me thinking.

Firstly, it needed conversion to cover the CW end of the band as well as the SSB section. This was easy as the varicap I had used was a double one as I couldn't find the correct one as specified by Derry. I found that by paralleling the two halves (no doubt someone will say you can't do that!) it worked fine - it covered 3.498 to 3.801 - exactly what I wanted.

The next part was to generate to CW. I thought first about re-injecting the carrier after the NE602, but that looked complicated. Then I remembered the TiCK chip invented by those two "Sons of the Dessert" Gary and Brad of Embedded Research. This had an audio output and if I could use that, I wouldn't need IRT because if I tuned my receiver to be the same note as the audio out of the chip, I would be zero beat with the other station. All I needed was to turn the 3+ Volt square wave into a microphone level sine wave. That I did with a single op-amp - a 741 connected as a simple low pass filter.

The circuit is easy. I made all up on a piece of Veroboard (strip board?) which took the TiCK and the LP filter. I used an off-cut which is why it is the shape it is!

The modifications to the Epiphyte were a DPCO switch which switched the audio input to the modulator between the microphone and the LPF output, I also switched the power to the LPF as the keying could be heard on receive if the paddles were touched. See Fig. 1

I used the TiCK circuit as recommended by Gary & Brad except that I added a large capacitor in parallel with the Tx/Rx relay to give semi break in as the Epiphyte clipped the cw a bit with full QSK. See Fig. 2. This was mounted next to the keying transistor on my PCB.

The only thing I did wrong initially was to power the TiCK down on phone. The TiCK I used was the one with a memory & it lost it's configuration if I switched to phone. I've since modified it to be powered all the time as it takes negligible current on standby.

The only adjustment needed is to ad-

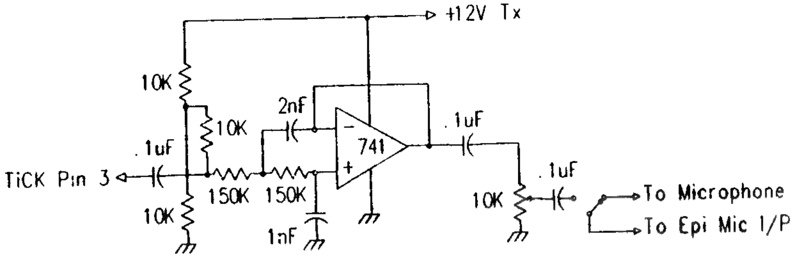


Fig. 1

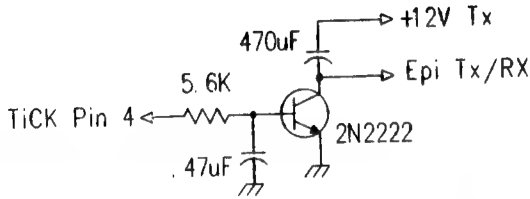
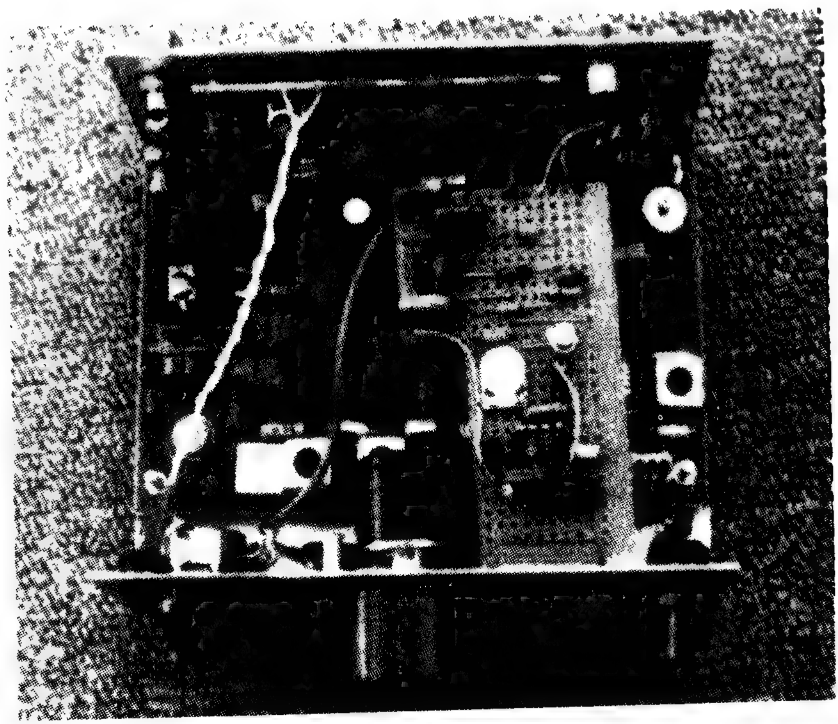


Fig. 2



CW Mod mounted on perfboard in Epiphyte II, Graham Firth Photo

just the output pot until the PA draws about 500/600 mA on key down.

That's it! Tony made a linear loaded dipole as described by W4RNL at FDIM this year and we worked around the UK on both phone and CW (when the family holiday permitted)!

The picture shows the Epiphyte board mounted in a Ten Tec case with the cw mod board mounted higher. The filter on the circuit diagram is a better one than the one shown in the photo - so it's a bit different.

Troubleshooting For Fun (and some mods to the SCAF filter)

by Preston Douglas WJ2V

Two years ago, at Dayton, I picked up a SCAF audio filter kit put out by an outfit called 624 Kits. (see OCT 92 QST for details--and note OHR still makes a complete version (including the case) of this exact same circuit--further note, you can buy the two hard-to-find chips for $8 apiece and the circuit board for about $5.50 from Far Circuits--the rest of the parts are standard, mostly available at RS) . Anyway, I picked up the 624 Kits version for a song at Dayton (I do not believe 624 is in business any longer, thus the above alternate source info is given for those who wish to build a SCAF for themselves.) The 624 version was just a bag of parts, no case, and no hardware. Nevertheless, I believe that the various versions of the SCAF filter are essentially interchangeable, so the modification advice below is applicable to all versions.

Now I have mentioned before that the thing about buying a kit from a reputable firm is that you have some safety net in case the product doesn't work. When they were in business, 624 Kits had a good reputation for support, but they aren't trading any longer. (Please, if that is incorrect, someone correct me.) Thus, I knew at the outset that any problems would be mine to solve.

So, I soldered it all up...and it didn't work. Aha, but this is a story about how much I have learned. Do you think it sounds silly to say that I almost hoped the project wouldn't work off the bat, so I could practice my troubleshooting skills?

Troubleshooting should be a logical process of continuous narrowing and elimination. Doctors and garage mechanics do the same thing, using different terms perhaps. And Doctors don't have the luxury of changing out suspect parts at will. But all of these professions use the same kind of decision tree, Ruling Out incorrect diagnoses as they proceed. (You'll see the term "R/O" in hospital charts. It means Rule Out some diagnoses in the process of finding out what is really wrong.) Actually, good auto mechanics don't start replacing suspect parts willy-nilly as this will cost the customer unnecessary expenses--I did say GOOD mechanics don't do that.

So here I was with my first opportunity to troubleshoot a new circuit by myself. What's the plan?

First, make sure the power is connected. Y'know, even your new VCR comes with a booklet with "In case of trouble" hints. And it says to make sure the thing is plugged in. OK, well that is always the first order of business. So, I reconnected the power and turned on the switch. At this point, then, here's what I knew from simple observations. It didn't smoke, so there were probably no power shorts. It made noise, so the 386 amp chip was probably working. And if it makes noise, it must have some power.

That accomplished, it is time to go over the parts against the parts placement diagram or the schematic. I hate this part of troubleshooting, but it must be done. The more compulsive (ok, careful) among us would already have done this part before ever turning the power on for the first time. Not me. Hubris, I guess. However,

it is very likely with new construction to be all the troubleshooting you need to do. If there is a wrong part in the wrong place, correcting the problem may be the whole cure. This particular SCAF kit had no parts placement diagram, and the parts were now obscuring the silk-screened parts values on the board itself. In that case, the schematic and the board must be compared, which is a job I just hate. But Ruling Out wrong parts has to be step one. Experienced, more methodical builders might chide me at this point for not having made a photostat of both sides of the PC board before building started--to aid in troubleshooting later. To them I say, I knew that. What I didn't know was that I would NEED to troubleshoot. (Which makes me a lazy wise guy. Tell me something I didn't know.) Anyway, the parts checked out ok on visual inspection and comparison to the schematic and the parts list. Also, an inspection of the solder side of the PC board for bridges and cut traces should be done under a magnifier. These flaws may be obvious, in which case you again have a cure. Or, they may be so small, only those damned little electrons know about the flaw. In this case, I could see no circuit board flaws. Again, though, a little advance planning would have meant I would have had a photostat to compare with the finished board to help look for subtle blobs of solder joining traces that shouldn't be connected. The problem didn't turn out to be a blob, though.

Now we need to do more thinking, and it is time to look at the schematic. The schematic is a valuable tool that comes with every kit and magazine project. In this case, the schematic shows the SCAF filter consists of two monolythic filter ICs and three other supporting ICs, one of which is a 9v regulator chip. Each of the other four chips has a pin to put 9v in. Always cherchez ("cherchez" = "look for" for you non French speaking philistines) the power. This means putting a voltmeter (Anybody out there not have a voltmeter? If you really don't have one, go spend 15 bucks at Radio Shack and stop embarrassing yourself) on each IC to see that they are getting their 9v. You have to look at the schematic and find the pin number on each IC that the power goes into. Then you count around from pin 1 counter-clockwise (from above the board) to the correct pin on each IC. Connect the voltmeter's + wire to each power input pin in turn, and the - wire to the ground.

In my non-working SCAF, digital voltmeter tests showed 9.01 v at the regulator (perfect) and at the power-in pin of each of the ICs. So far, so good. We have now Ruled Out power distribution problems.

Now it's time to look at the schematic some more. Recall I said the filter chips in the SCAF are monoliths. This means almost nobody knows (well I certainly don't) just exactly what goes on inside them, but when they are connected up, they process signals. Signals go in the black box and come out. At least, then, they have to have an input pin, and output pin, a power pin and a ground pin. Uh huh. There they are on the schematic. And wait a minute, these chips have to have a clock, like a computer does. That is, they need a signal (square wave, usually) to tell them when to start processing and stop processing very rapidly--or something like that. Anyway, they need a square wave input. Having RULED OUT power distribution problems, we have two places to still look. We can follow an audio signal from the input connector to the input pin on the fi. t filter chip and back out on the far side. l hat's easy enough. I connect the main station receiver up to the input connector on the back panel, and go get my Radio Shack audio amplifier. (If you don't have an audio amp handy, you can follow an audio signal with a pair of earphones--following an RF signal would have been a bit harder.) Setting the main station rig on one of those

7 MHz European broadcasters gives a very nice carrier (See, they are good for something besides QRMing the Novice band). To be clear, I connected a cable from the audio or phones output of the rig to the input connector on the SCAF and followed the audio signal from the input connector right to the input pin of the filter IC. It's there, all right. And, look here, it doesn't come out on the output pin of the IC. Well, we have signal in, and we have power in. Ruled those out. What's left?

So, how about the 555 clock? Now for the good part. I warmed up the Tek 465 scope. (I waited 20 years to buy that scope--what a pleasure it is, too.) Wait, you say? That's cheating? Using a scope makes it too easy? OK, I admit it. It does and it did. I could have struggled to cobble up a diode rectifier and earphone, but why struggle when the scope is there? I mean, we do QRP to make operating more challenging, but troubleshooting with one hand tied behind my back...well, that's going too far. Anyway that's why I bought that beautiful scope. Regardless of the method you decide to use to detect the clock signal (which runs at about 75000 Hz or 75 kHz), the idea is to follow the clock signal from the output pin of the 555 chip to the input of each of the filter ICs. The ground pickup goes again to the neg. side of the power plug. Put the probe on the 555 output pin, and there are the nice square waves. Since the clock is meant to be variable, it make sense to see that the signal varies in wavelength as the pot is turned. The scope shows the waves do indeed change wavelength as the pot is turned. In my still-sick SCAF I have now Ruled Out the 555 circuitry as the culprit--there is a good clock signal.

OK, now to check that the clock getting to the two monolythic filter chips. Check the schematic to find the pin numbers on the filter ICs for the clock inputs. Put the probe on the clock inputs. NADA. NO, the clock isn't getting to the filter chips. This looks too easy. But yes, eureka, that was it. With the magnifying lamp and a magnifying glass together (a homemade compound microscope!) , I find there's a tiny cut clean through the trace that's supposed to carry the clock square wave to the filter chips. This cut was too small to find in my earlier visual inspection, unless I had known where to look. (Do I remember messing around trying to clean up something else with an Xacto knife and slipping? Maybe. Or, maybe it was a mis-etch in the Far Circuits PC board--624 Kits used the same Far board as cited in the original QST article.) Now all that's needed is a bit of wire and solder to bridge the gap, and.... It plays! The satisfaction in doing a successful troubleshoot is just wonderful.

Do I like it? Well, others have already extolled the virtues of the SCAF. I haven't even had it on the air yet. I can tell you that the remarkable thing about it is its lack of "ring" and par-focal (to borrow a microscopy term) ability to keep the center centered and the volume even, regardless of filter width. And wow, the 108 Hz filter is tighter than a duck's rear. Simple dual op amp filters can't touch this filter.

Mods. I did David Snowdon's mods from his 9/16/97 QRP-L post (see following article). This mod gives a great improvement--adding two more bandwidth choices of 1100 and 1500 Hz to improve flexibility in SSB reception, and Snowdon's post includes two other mods (crediting Larry East and Bill K5BDZ) for quieting the '386 hiss. While these mods were written for the OHR kit, they apply to all versions of the filter. These are dead easy, worthwhile mods that can be done on the fly, as you build. And I did them that way. Also, see Paul Carreiro's article about about improving the amplification/ switching arrangements in the filter on page 72 of this issue. Carreiro's is another worthwhile improvement, that I plan to add before I close up the box.

And now for my own little mod: Don't use the on-board trim pot to set center freq. Bring out the pot connections with a pair of wires from the PC board to the front panel and connect them to a 10k panel mounted pot. This will give you a variable center freq, to allow the filter to be used with many rigs, each of which is likely to have slightly different pitch when sigs are centered in their IFs. If you have the test equipment to get an accurate AF freq readout, you might want to set the filter for the narrowest bandwidth, and then mark a spot on the front panel where the pointer on this pot centers on a 700 Hz tone, so you have a reference point. (I have never seen the OHR SCAF kit--is the pot on the PC board in their version? Or did they put it in front?)

Anyway, I literally couldn't have made this project live without the knowledge I gained on QRP-L. Now, I have another tool to dig the Foxes out of their holes. 72, Preston WJ2V

A Couple of Mods for the OHR SCAF

by David Snowdon, VA3DKS
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Here are a couple of modifications that I made to my OHR SCAF that improved the design and allowed me to use it with my Drake R8 for better SSB listening; as well as removing a lot of audio hash coming from my Realistic PRO-2005 scanner.

Mod 1

The SCAF is great for CW reception since it has five selectable bandwidths. However it only has one SSB bandwidth at 2440 Hz, limiting its usefulness. This modification will add two more SSB bandwidths of 1570 and 1170 Hz. You will need: a 1 pole, 8 position rotary switch with a 1/4" shaft (Dan's has these for $1, or $0.75 if bought before Oct. '97), two pieces of insulated wire, 3 1/2" long, and three Silicone diodes such as 1N914, 1N4148 etc.

Remove the knob from the rotary switch and then remove the three nuts and washers holding the two switches and headphone jack to the faceplate. Then remove the four screws which hold the printed circuit board to the chasis. It's easier to keep the LED attached to the faceplate. Just remember to be careful moving the printed circuit board about so that the LED wires don't get twisted.

Carefully unsolder the wires connected to the original 6-position switch. Rotate the shaft of the 8-position switch counter-clockwise so that it is set at the 2440 Hz bandwidth. Note which of the eight pins on the switch that has been engaged; and solder the brown wire to this pin. Then solder the two new 3 1/2" wires to the next two pins. Finally soldier the five other wires on to the remaining pins.

Bandwidth	Wire Color
2440	BROWN
1570	your choice
1170	your choice
574	RED
459	ORANGE
383	YELLOW
230	GREEN
108	BLUE

Place the circuit board so that the line of ten diodes is directly in front of you. Cut off the leads of the three diodes so that 3/8" remain. Using needle-nose pliers, for each of the three diodes, bend the end of the cathode (banded side) into a small u-shape.

Locate D1 on the circuit board (rightmost of the ten diodes) and place the u-side of one of the three diodes (we'll call it CR1) under the cathode end of D1. Use the pliers to squeeze the u-side of CR1 around the lead of D1, and then solder this connection (try to keep CR1 upright).

Located D5 and repeat the above so

that the cathode of CR2 is soldered onto the cathode of D5. Located D7 and repeat again with the third diode (we'll call this diode CR3).

Bring together the two free ends of CR1 and CR2 and the wire which goes to the 1570 Hz position of the rotory switch. Solder this junction. Solder the 1170 Hz wire to the anode of CR3.

The Oct. 1992 QST article on page 27 (Table 1) explains how this mod works.

Mod 2

Reducing hiss from the headphone amplifier is easily done by placing the positive end of a 10 uF electrolytic or tantalum capacitor between pin 7 of the LM386 IC and ground (minus side of C9). (Thanks to Larry East W1HUE and Gary Surrency AB7MY re: QRP-L Feb 28 '97).

Mod 3

Further hiss reduction can be accomplished by adding a 15 Kohm resistor (BRN GRN ORG) and a 4700pf capacitor (472) in series across pins 1 and 5 (actually soldered to C10 due to length of the two parts) of the LM386 IC. (Thanks to Bill K5BDZ re: QRP-L Aug 5 '97)
72, David, VA3DKS

SUPED UP OHR SCAF

by Paul F. Carreiro N6HCS
carreiro@barepower.net
[First published on QRP-L, 4\ 11\97]

The Oak Hills Research (OHR) Switched Capacitor Filter (Model SCF-1A) is a niffty little accessory for any ham's arsenal. 5 selectable audio bandwidths from 2440 Hz to 108 Hz can be chosen to improve reception in adverse conditions. Absent however, is a through position when no filtering is needed or desired. When SCF power is turned off, all audio throughput ceases. This bugged me from day one of operation of my SCF.

One of my other pet peeves is the QRP audio that most QRP kit rigs produce. This usually requires the use of headphones, even in a quiet room. Straight speaker operation is just about out of the question in alot of situations. Then I read Richard Fisher, KI6SN's article (World Radio, June 1995 Issue, Page 54, QRP Column) and knew the quashing of my pet peeve was at hand.

His article describes the use of the Radio Shack 1 Watt Audio Amplifier Kit (R.S. #28-4031, $9.99) and how it can be used in any number of QRP rig applications. I decided to follow his lead and incorporate the 1 Watt Amp into the OHR SCF unit along with some other simple modifications that I've been threatening to do since I constructed the SCF. The simple modifications I chose to make are:

1) add the Radio Shack 1 Watt Audio Amplifier Kit with volume control and switchable gain;

2) route audio such that the SCF and audio amp are individually bypassed when either is powered off;

3) improve the input/output connector scheme; while minimizing the need for new holes drilled in the cabinet.

The 1 Watt amp is physically small (24X38mm) and can be mounted with one standoff from an existing SCF PC board mount. Make sure to use the amp board hole closest to the audio input to ensure circuit ground is applied to the board. This eliminates the need to provide separate wireing for power and audio ground. You'll need to short "C" and "G" on the bottom of the board as described in the directions. Note: the audio input ground must be left floating for noise suppression in this configuration (read instructions for more information).

I use two 3PDT switches to simutaneously provide power and audio

input/output to the SCF and audio amp. When the SCF switch (S1) is in the "OFF" position, power is removed and audio is bypassed around the SCF. The second switch (S2) does the same for the power amp, which is down stream audio wise from the SCF. Using this scheme, the unit can act as an SCF only, audio amp only, or both.

Mechanical addition of the amp's volume control and switch is quite easy. The SCF's power LED, Rx and terminal board are removed. The amp's on/off switch (S2) is placed in the hole left behind by the LED. The front panel 1/4" phone jack is moved to the back panel (via a newly drilled hole). The amp volume control is placed in the front panel hole vacated by the 1/4" phone jack. On the rear panel, I added a SPST switch for amplifier gain (26/46db, optional), the moved 1/4" phone jack already mentioned and a new 3.5mm jack wired in parallel with the 1/4" jack for versatility (optional). I also replaced the audio-in pigtail containing the 1/4" phone plug with a female RCA jack, also for versatility.

With the described modifications, only three holes were drilled, two of which are optional. This results in a nice looking, ergonomic and functional arrangement. I used my SCF with the above modifications at the Zuni Loop Field Day. Operation was much more enjoyable with this niffty little accessory. Thanks to KI6SN for turning me on to the Radio Shack amp, and Tony, N6OAT for opening my eyes to the mechanical ease of these modifications. Enjoy es 72, Paul N6EV

Mods to Improve the OHR SCAF

by Marshall Emm, AA0XI/VK5FN
aa0xi@mtechnologies.com

My situation was that I wanted to use the SCAF with either of two rigs having substantially different audio output (the OHR400 has fairly low output and the IC735 has multiple watts available), so I wanted to be able to add in some amplification. I also wanted to use either headphones or an external speaker (my brief AF career is paying off now in high frequency hearing loss, and I find a speaker a little more comfortable most of the time).

Also, my "rev 1" SCAF is non-op when switched off-- have to take it out of the circuit. I think a later version introduced a double-pole switch which acted as a bypass when the unit is off.

So... the design goal was to select either of two inputs, and enable either an audio amplifier or the SCAF, or both. I decided not to worry about switching the input-- it comes from the headphone jack which is on the front of the rigs, so it's easy enough to swap over, but did the other two.

The arrangement was to add a speaker jack on the back of the unit (wired to the already available switched connection on the SCAF's headphone jack) so the speaker is on until/unless I insert a headphone plug.

Two DPDT switches control both audio and power switching, and I put LEDs on the hot side of the power switches so I can see what's on. The two switches are for the SCAF and the audio amp (an RS LM386 amp which fits neatly inside the SCAF case. One side of the switch controls audio, the other controls power.

Looking at the thing from the input side, the signal first encounters the SCAF switch. It goes to the center terminal on the switch, which sends it either to the SCAF unit or to the audio switch. In the on position, the other side of the switch sends +12v to the SCAF unit and lights an LED.

The output from the SCAF is tied to the "bypass" audio line from the SCAF switch-- one side or the other will be dead, depending on the switch position-- and then to the audio amp switch.

The audio amp switch is set up the

same way-- one position bypasses the amp (and turns power to the amp off) and the other goes to the input of the amplifier. The "bypass" audio line from the amp switch is tied to the output from the amplifier, and goes to the source connector on the headphone jack.

The SCAF was wired internally with ordinary hookup wire, and the SCAF was a bit susceptible to RF (principally from my nearby 2M rig), so I did all the internal audio wiring with mini coax. While I was at it, I replace the "gain control" trim pot on the audio amp with an off-board pot on the back of the SCAF enclosure. It's not really a gain control, of course, just a 50K pot across the input to the amp.

The external speaker is a 10" Jensen PA speaker that I got at a swap fest for a buck, and unlike the car speaker and the RS speaker that I tried, will not distort when driven with a full power (1W) signal at 700Hz. It works very well, and makes a world of difference in terms of convenience. 73, Marshall Emm, AA0XI/VK5FN

Adding Sidetone & Receive Offset to the Pixie, the TiCK Way

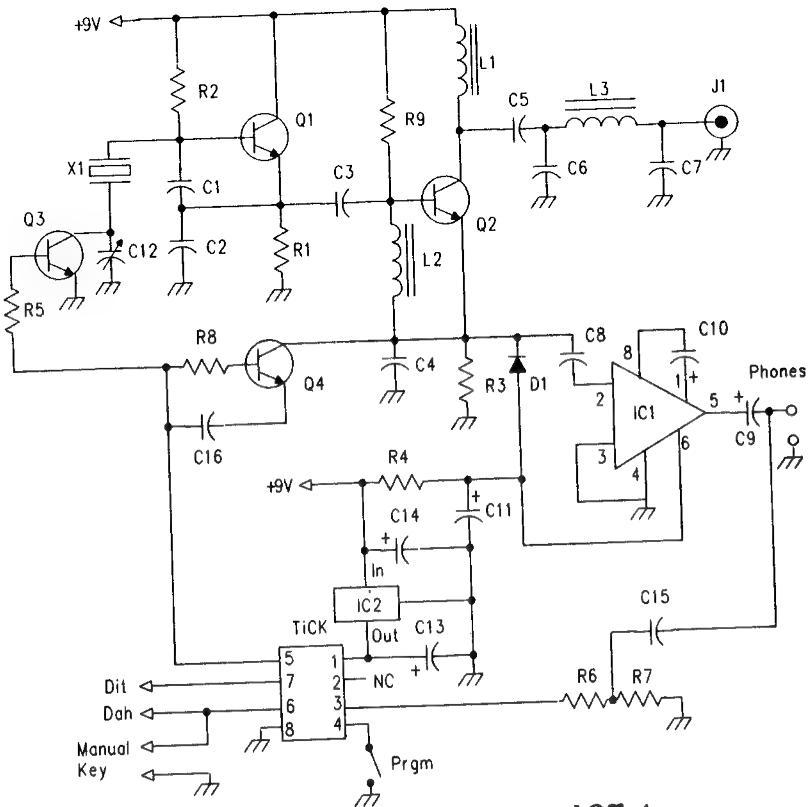
by Charles J. Ludinsky, K1CL
cjl@mail09.mitre.org

Two of the most requested modifications to the Pixie2 are sidetone and receive offset. Since I was planning on building a TiCK keyer into one of my Pixies, I saw a good opportunity to add both features with a minimum number of additional components. Sidetone is included as a basic feature of the TiCK; the main issue is how to couple it into the Pixie. Offset can be implemented by duplicating the keying transistor circuit, and using it to switch a small capacitor in and out of a series connection with the crystal.

The basic approach is to use the TiCK keyer board (supplied by Embedded Research) essentially without change, and to add only three additional, off-board components to implement the sidetone and offset features. In the "just do it if it works" tradition of the Pixie2 (exemplified by the manner in which the audio amplifier is muted by shorting its power supply), I simply connected the audio line of the TiCK keyer through a resistive divider and capacitor (located on the keyer board) to the headphone jack. This approach works reasonably well, despite the fact that the keyer audio is "fighting" against the low impedance of the audio power amp. This results in considerable audio distortion while in the TiCK programming mode, that is, when the amplifier is turned "on". However, the tones are still quite intelligible. During transmission (with the amplifier effectively turned off), the keyed sidetone is relatively undistorted. The sidetone level is set by the ratio of R6 to R7. Values given in the diagram are what I found reasonable; however, these can be set to whatever values give the best volume.

For offset, I duplicated the keying transistor circuit (using one transistor, Q3, and one resistor, R5), with the collector/emitter junction connected across a small capacitor (C12) in series with the crystal to ground. A trimmer capacitor of about 5 to 50 pF is used, allowing the offset tone to be adjusted as desired. This circuit seems to work quite well, with no apparent chirp or other problem, despite the lack of a DC collector voltage. Tests with and without DC current through the transistor showed no appreciable difference in frequency shift, chirp, etc. One additional change that might be useful (not shown in the diagram) is an SPST switch across the capacitor; this allows the offset to be turned off when desired.

These changes give a whole different flavor to the Pixie -- almosts feels like a "real" rig. The addition of a simple audio filter, such as that used in the W1FB ver-



K1CL Pixie with TiCK Sidetone and Offset

sion of the Pixie should help even more. However, all of these additions do increase the complexity of what was originally meant to be the ultimately simple transceiver.

Parts List:

C1,2	100pF
C3	82pF
C4	.05uF
C5,15	.01uF
C6,7	820pF
C8	.1uF
C9,10,11	10uF/16V
C12	5-50pF Variable Cap
C13,14	1uF/16V
C16	.001uF
D1	1N914
IC1	LM386
IC2	78L05
IC3	TiCK Keyer Chip
J1	BNC Antenna Connector
L1	15uH
L2	100uH
L3	2.2uH
Q1,3,4	2N2222
Q2	2N3053
R1	1.5K
R2	47K
R3	10K
R4	1K
R5,6,8	4.7K
R7	8.2K
R9	33K
SW1	N.O. Momentary PB Switch

Good luck and I hope that you enjoy your "Pixie" as much as I have. 72, Chuck, K1CL

OSCILLOSCOPES (Part 2)

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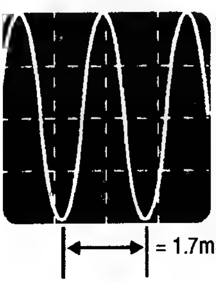
In Part I, oscilloscope operation was covered for making basic voltage, time and frequency measurements. In this article, we'll continue with some more advanced uses of a scope, and in particular, how to use a scope for testing and troubleshooting QRP rigs and in the homebrewer's workshop. It may be noteworthy to mention that some of the alignment procedures and tests that follow can be performed with a DVM as well.

Receiver Filter Bandwidth.

This procedure uses a scope (or DVM) for determining the overall filter bandwidth (or selectivity) of your receiver. It is basically measured by plotting output voltage vs. audio frequency to construct a picture of the filter response.

Connect scope to the receiver audio output; measurements will be based on peak-to-peak (Vpp) voltage. (or rms (Vrms) voltage on a DVM).

Using a signal generator set to about 7.040 MHz (or wherever), tune receiver to the signal for desired sidetone, or tune in a steady carrier or shortwave hetrodyne. Adjust scope and audio volume for about a 2Vpp display of the signal. Now carefully tune in the signal to the pitch that causes the maximum peak-to-peak magnitude. Adjust scope for exactly a 2Vpp display. This is the peak response of the overall filtering stages as shown below.



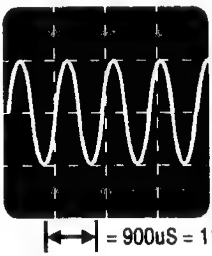
VERT: 0.5v/div DCV
HOR: 1.0mS/div

Set peak filter response for 2Vpp vertical display, then determine audio frequency.

= 1.7mS = 750Hz audio tone

Now determine the audio frequency at the peak response by measuring the time period between cycles and converting to frequency. In the example shown, the period is 1.7mS, which is an audio tone of 750Hz. Record this data. (i.e., 2Vpp - 750Hz). A frequency counter on the audio output can also be used.

Now tune the receiver so the sidetone pitch goes UP in frequency and the peak-to-peak signal will decrease in magnitude. Tune to the point where the signal is exactly 1Vpp on the scope ... this is one of the -6dB filter points (20log 1v/2v=-6dB). Determine the frequency of the audio pitch, which in the example is 1100Hz as shown below. Record the data.



VERT: 0.5v/div DCV
HOR: 1.0mS/div

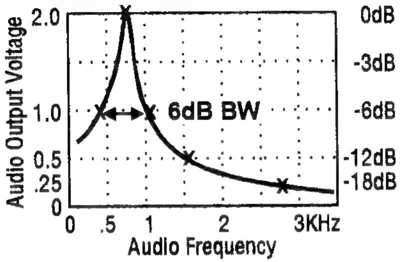
Set peak filter response for 2Vpp vertical display, then determine audio frequency.

= 900uS = 1100Hz audio tone

From these two data points, the -6dB bandwidth can be estimated ... the bandwidth from the filter peak to the -6dB point is 1100-750Hz or 350Hz. The bandwidth between the two -6dB points is usually twice this value, or 700Hz. A filter with a -6dB BW of 700Hz is a mediocre filter for CW work.

To determine the second -6dB point, tune the receiver back to the peak response frequency (750Hz) and continue tuning so the pitch goes DOWN in frequency until the audio signal is again exactly 1Vpp. Determine the frequency and record. In this example, it should occur about 400Hz if the filter shape is symmetrical.

Plot these three data points on a sheet of graph paper as shown below to construct the filter shape. You can return to the upper -6dB point (1100Hz) and continue tuning upwards in audio pitch, recording the frequency at 0.5v, 0.25, 125mV, etc. Everytime you "halve the voltage," it is a 6dB change. The more points you collect, the more accurate your filter response plot will be.



Of interest to proper rig alignment is to repeat the above using the output of the product detector. To maximize the effectiveness of the filtering, the receive offset frequency set by the BFO should be adjusted to the same frequency as the peak frequency response of the filter. In this example, if your sidetone is set for 700Hz, you are loosing 3-4dB since you are actually in your filter skirt.

Opposite Side Band Rejection.

A superhet receiver is supposed to pass one sideband and reject the other. Poor opposite sideband rejection could indicate the crystals in your IF filter are not well matched or other problems. It is measured almost identical to plotting the filter response. First, you tune the receiver to the test signal to find the peak response frequency, which in our example is 750Hz. Set the scope display for 2Vpp. Now tune downward in audio pitch, continuing to the other side of zero-beat and find the opposite sideband signal, which should also occur around 750Hz. Measure the peak-to-peak voltage if you can. For example, say it is 80mVpp. Calculate the opposite sideband rejection by:

$$\text{rejection} = 20\log\frac{80\text{mV}}{2.0\text{V}} = -28\text{dB}$$

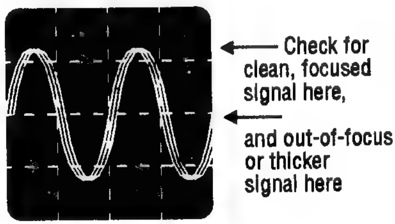
If you can't hear the opposite sideband then you obviously have excellent filter rejection. If you can just barely hear it, you may have to increase the peak response display from 2V to say 4V to see the opposite sideband signal on the scope even at 20-50mV scales.

These tests are important to perform on your rig for documenting it's current performance, and repeated periodically to detect unfavorable changes or for troubleshooting. For homebrewing, these tests can allow you to evaluate different circuits or component values.

Oscillator Phase Noise.

When homebrewing a basic VFO, looking at the oscillator output on a scope can reveal several problems. One is to check for excessive phase noise. Phase noise is small variations of the oscillator frequency that causes power in the close-in sidebands, usually measured on laboratory equipment within 10KHz.

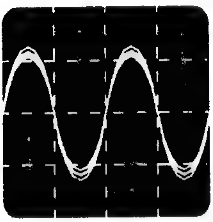
To check for oscillator phase noise, connect the oscope to the oscillator output, loading the output as little as you can (couple with a 5-10pF cap) and display 2-3 cycles as shown below.



Properly focus the scope and carefully observe if the waveform appears in focus at the peaks, but slightly out of focus at the zero-crossing points, that is, on the rising and falling edges of the sinewave. This is excessive phase noise, and the out-of-focus look is caused by very small instantaneous changes in the oscillator frequency which will "smear" the display in the time axis. If you can see this on a scope, the phase noise is excessive. If you can't see it, it doesn't mean the oscillator has no phase noise (all

oscillators have some phase noise), it just means it is not excessive and likely acceptable. Excessive VFO phase noise can cause IMD products and noise in the audio range at the mixer output, including the product detector. A few causes of oscillator phase noise are excessive current in the oscillator transistor, low-Q coil, high dissipation in the tuning caps or poor power supply filtering at the oscillator frequency.

AM (Amplitude) Noise.
Another oscillator problem may be AM noise, or amplitude modulated noise. It is an opposite effect on a scope when displaying the oscillator output ... the sinewave appears out-of-focus or thicker at the peaks, and in-focus elsewhere as shown below.



Check for out-of-focus signal here,

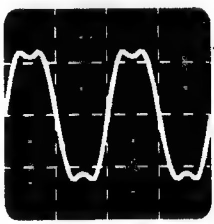
and in-focus signal here

If you detect AM noise, slow down the scope's sweep rate to the audio frequencies or lower to see if you can notice a lower frequency component. A common cause of AM oscillator noise is 60Hz from the power mains leaking into the circuit. This is particularly true if using a power supply off of 110vac, or sometimes just due to the ac lighting above your head! If the AM noise seems to be at the same frequency as the audio output tone, it means audio is getting into the Vcc bus, likely due to poor bypass filtering at the audio amplifier, particularly if using an LM386. If you can't find a low frequency component, the AM noise may be random, which may indicate poor voltage regulation or a noisy voltage regulator. And if the AM noise seems to occur on key down, the transmit current may be loading the power supply, the voltage regulator, or just loading the oscillator. In the case of loading down the power supply or regulators, perhaps a separate voltage regulator or zener circuit should be used dedicated for the oscillator(s). In the case of transmit loading, adding a buffer amplifier or emitter follower to isolate the load from the oscillator may help.

Much of this can be diagnosed also with the scope, by looking at the AC ripple on the DC power. You should have less than 50mV of any AC component on the 8-12v DC wiring, whether 60Hz, audio, or RF. If >50mV, then additional low or high frequency filtering on the DC power is needed.

Monitoring RF Output

RF Power (in watts) is E^2/R, where E is in rms and R=50Ω. The voltage on the scope must be converted to rms by Erms=.707(Epp/2). To measure properly, the transmitter should be on a 50Ω dummy load using the normal hi-Z scope input. If your scope has a selectable "50Ω" input, it can be the transmitter load directly, providing it can tolerate the 50Vpp input. The example shows how a 30M RF output of 24Vpp equates to 1.4W. (A 5W output is 45Vpp or 16Vrms at 50Ω).



24Vpp=8.5Vrms

P(watts) = $\frac{E^2}{R} = \frac{8.5^2}{50} = 1.4W$

VERT: 10v/div DCV

HOR: 50nS/div

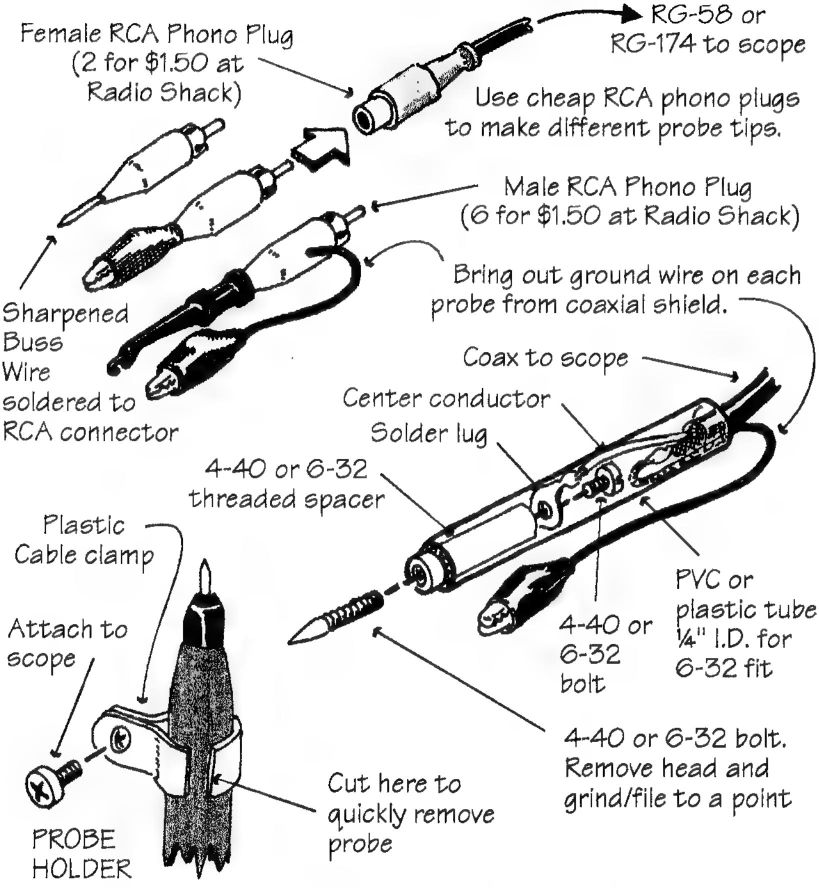
10.1MHz RF Output

Harmonic Power can also be detected on a scope while looking at the RF output. In the example above, notice the "dips" or the two-peaks on the top and bottom of each sinewave. This is an indication of excessive 2nd harmonic output power. The rule-of-thumb is if you can see **any** 2nd harmonic power (a dip at the peaks), then you are right at or exceeding the -30dBc FCC harmonic specs. A clean sine-wave implies FCC compliance, providing the 2nd harmonic frequency is within your scopes bandwidth.

Some O-SCOPE "HINTS & KINKS"

Doug Hendricks, Editor magna-opus and fellow Area 51 veteran, told me I had 7 pages for "Hints & Kinks" and the scope article combined. So which one do I make 3 pages, and which one four? So I decided to make the odd-page both! Only QRPers can get 8 pages out of 7 to make printing history!

HOMEBREW SCOPE PROBES



Standard Tektronix Probes for 475 and earlier scopes

Type	Description	Conn.	-3dB BW	Loading
P6101	Universal 1X probe	BNC	dc- 34MHz	1MΩ, 32pF
P6103	Universal 10X probe	BNC	dc- 50MHz	10MΩ, 11pF
P6102	Std. Tek 10X probe	Mod.	dc- 60MHz	10MΩ, 13pF
P6105	Std. Tek 10X probe	Mod.	dc-100MHz	10MΩ, 9pF
P6062	Selectable 1X	Mod.	dc- 8MHz	10MΩ, 100pF
	or 10X		dc-100MHz	10MΩ, 13pF

Connector: "Mod" is Tek modular BNC with built-in 1X/10X coding pin for readout. Above probes available from Tektronix, but range from $65 to $115 per set. For replacement, see ITT/Pomona models 5621, 5622, 5702, 5703 for about $35.

QRP HINTS & KINKS

A NorCal Exclusive

#6

Illustrated by Paul Harden, NA5N (NA5N@Rt66.com)

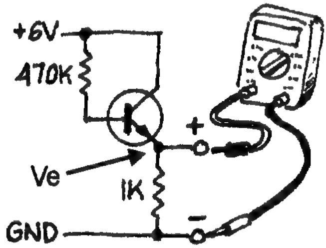
Hints & Kinks with the 2N2222

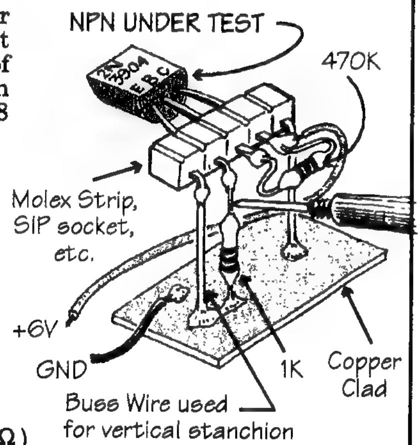
Since the 1998 building theme for Dayton and PacifiCon seem to be based on 2N2222's (see announcement page 4), the next couple of ***Hints & Kinks*** will focus on these famous NPN's.

A Simple NPN HFE Tester

From Kent Torell, AB7OA (Scottsdale, AZ)

AB7OA made this simple tester for grading NPN's by their dc current gain (HFE). 2N2222's have an HFE of 150-200. The average measured with this circuit of a dozen units was 188 and the Vbe was 0.62v.



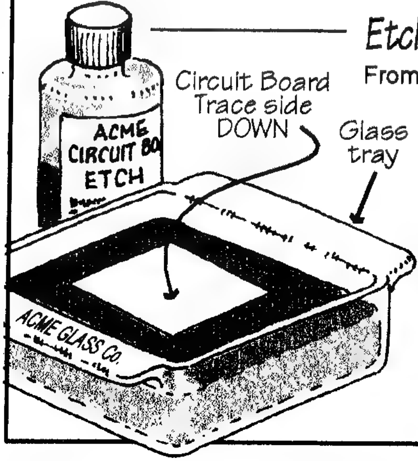


Current (mA) = Ve in volts (I = Ve/1000Ω)

HFE=Ic/Ib = Ve*470/(6v-.62v-Ve) Example: If Ve = 1.5v, then HFE=182

Etching Home-brew Circuit Boards

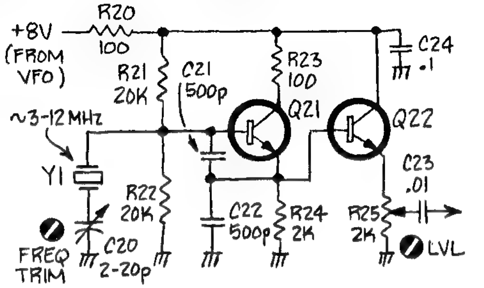
From Gary Diana, N2JGU (Rochester, NY)



One secret to better boards is keeping the solution "clean" during etching. Plastics and aluminum breakdown contaminating the etch -- use a glass cooking pan. The etch should be warm (about room temperature) - not cold. Place board *circuit side down*, so debris from the etching process can fall to the bottom of the pan - not pooling on the etched surfaces causing ragged or pitted traces. This method also requires less agitation.

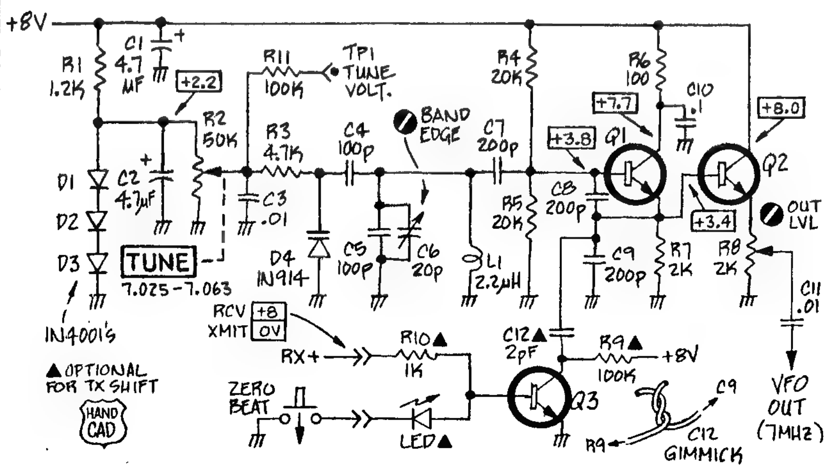
A Junk-box 2N2222 VFO

This project was designed and built specifically for this ***Hints & Kinks*** -- oscillators for the 2N2222 contest rig, or as test oscillators for the shack. The project shows how to build two oscillators "ugly" virtually step-by-step -- a crystal oscillator and a 7 MHz VFO. Either can be used as the LO for a direct-conversion rig, or used together for the VFO and BFO in a superhet. For a superhet, the VFO can be re-tuned to the desired 1st LO frequency.



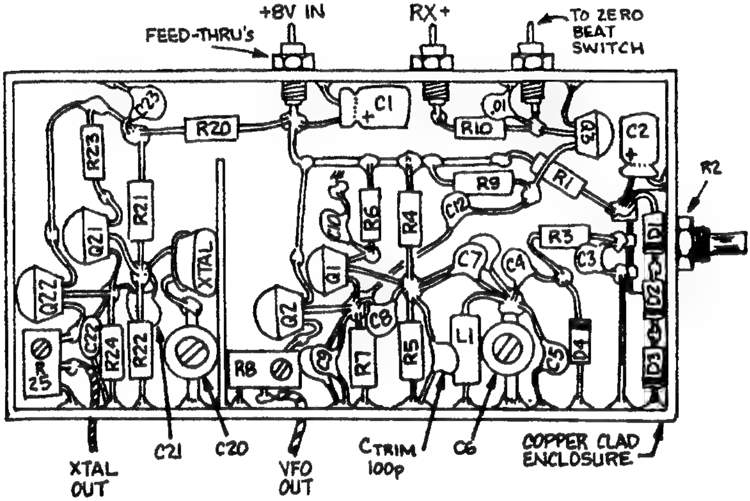
Schematic of the Crystal Oscillator

The objective was to use parts of the same values where possible. For example, the biasing resistors (R4-5, R21-22) are all 20K, though any value from 10K-50K will suffice. VFO tuning is based on 100pF caps, such that C8, C9 (200pF) are two 100pF in parallel, etc. **On the xtal oscillator**, C21-22 can be 270-1000pF; they provide the feedback, not the tuning. C20 can be larger for more "bending," or the varicap circuit of the VFO (from C4 backwards) can be added to the xtal for electrical tuning. **On the VFO**, L1 is a 2.2uH fixed inductor (Mouser 434-22-2R2, 36¢) or peaking coil (43LR226, 46¢), or toroid. A 1N914 diode is used as the varactor by tuning over a 0-2v range, for which D1-D3 1N4001's (or more 1N914's) are used as a low voltage regulator (we're talking cheap here!). All transistors are 2N2222, 2N3904, etc. C6 sets the low-end band edge. R3,D4,C4 sets the tuning range, which may have to be trimmed to compensate for the capacitance of your 1N914, 1N4148, etc. VFO frequency determined by L1 and C5-C9, which for values shown tunes 7.0 to 7.10 MHz. ***Not shown on the circuit*** is a 100pF cap across R5 (C8-C9) which reduced the tuning range to 7.025 to 7.063 MHz (FOX hunting range!).



Schematic of the 7 MHz VFO

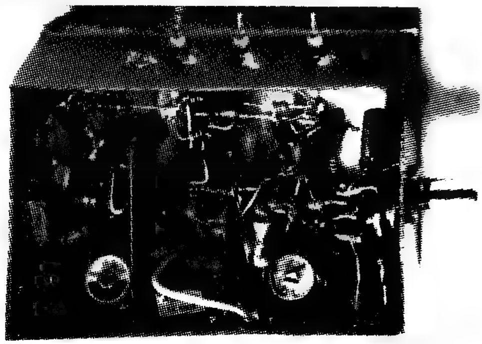
Q3 is the **xmit offset switch**. When RX+ is +8v, Q3 conducts adding C12 to the circuit for about a 800Hz shift; when RX+ goes to 0V for xmit, Q3 is off and C12 is removed from the circuit. C12 (1.5-2pF) can be made by making 2-3 turns of #22 hookup wire as shown on the schematic ... twist for desired shift. The push-button switch can be added to remove the shift for zero-beating. This optional circuit was added to offer an idea on how to incorporate zero-beating and RX shift with a direct-conversion receiver (and it does work). On both oscillators, Q2 and Q22 are emitter followers to isolate the load from the oscillator. R8 and R25 are optional and can be fixed. A 500 ohm resistor for R8/R25 produces +5dBm output ... sufficient to drive most passive mixers, or 2K for -10dBm to drive active mixers.



Both oscillators were built in a homemade enclosure of copper clad about 2x3", 1" high "walls," covered with steel door-screen. (See photo below). Very little leakage occurs (important in D-C receivers). Enclosing any VFO is good practice. I used feedthru's 'cuz they were handy, but not required. Tests were performed at +8v (see voltages on circuit), but operates from 6-12v. There is nothing sacred about the parts layout shown above ... in fact when building ugly, you just kinda make it up as you go along. The circuit could be built much smaller. I built this one rather 2-dimensional for illustration purposes.

If you find the schematic or parts layout a bit small, send me an SASE and I'll send you a copy of the full-sized drawings and a Mouser parts list. This is the VFO used in my "2N2" rig. A foot long wire on the VFO output makes my NW40 sing 30 feet away. Heck, that's a QRPp rig right there!

72, Paul NA5N



NorCal K8FF Paddle Kits

The NorCal Paddle Kit will consist of all the parts needed to build the kit, including the base, machined brass parts, and all hardware. The kit is unfinished. The machining has been done for you, but it is up to you to finish the kit by polishing the brass parts and painting or plating the base. The cost of the kit is $30 plus $5 shipping and handling in the US, $10 shipping and handling for Western Europe and Canada, and $15 shipping and handling for the Pacific Rim. To order send your check or money order (US Funds Only) to: Jim Cates, 3241 Eastwood Rd., Sacramento, CA 95821, USA Make checks and money orders out to Jim Cates, NOT NorCal.

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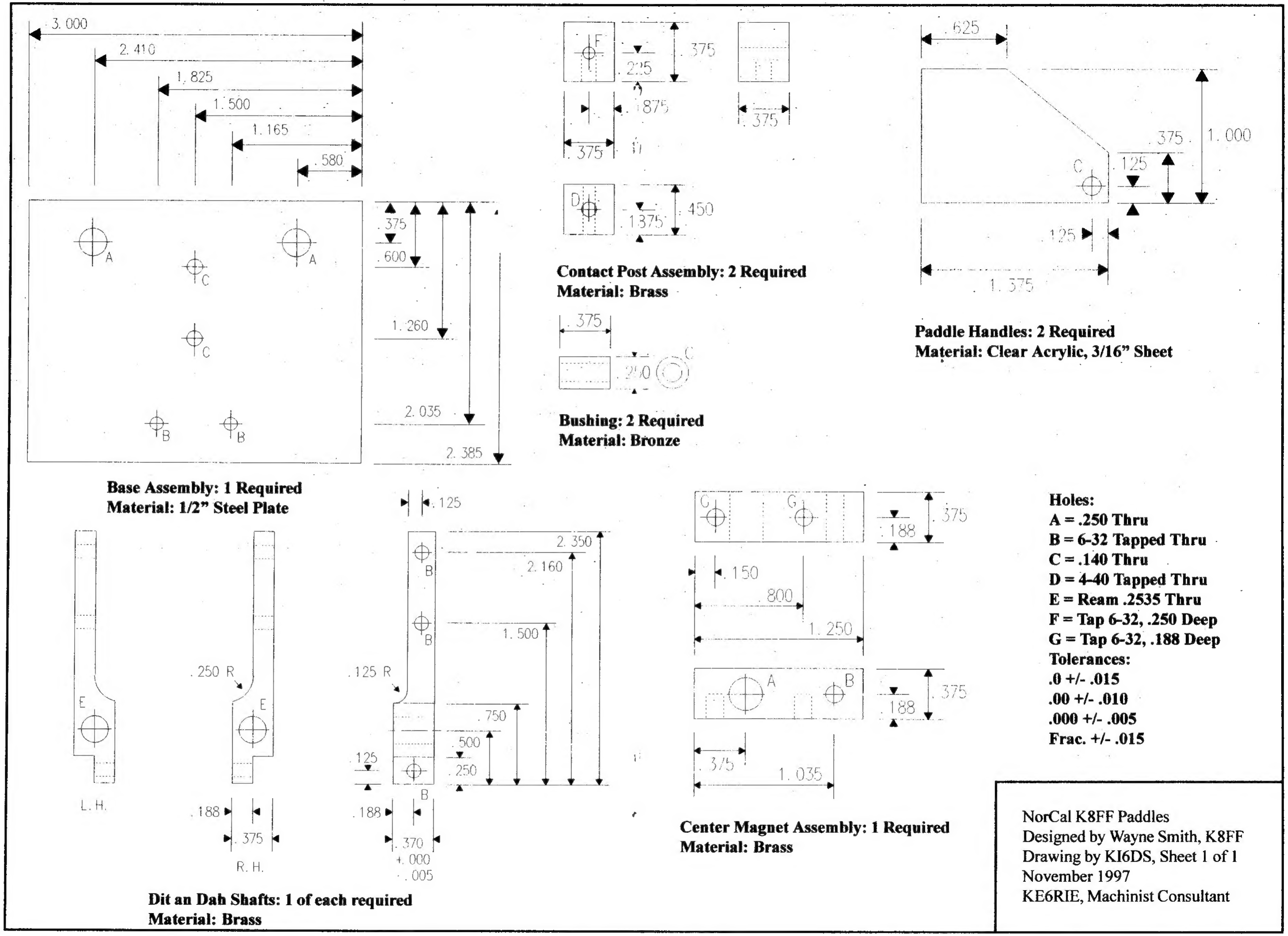
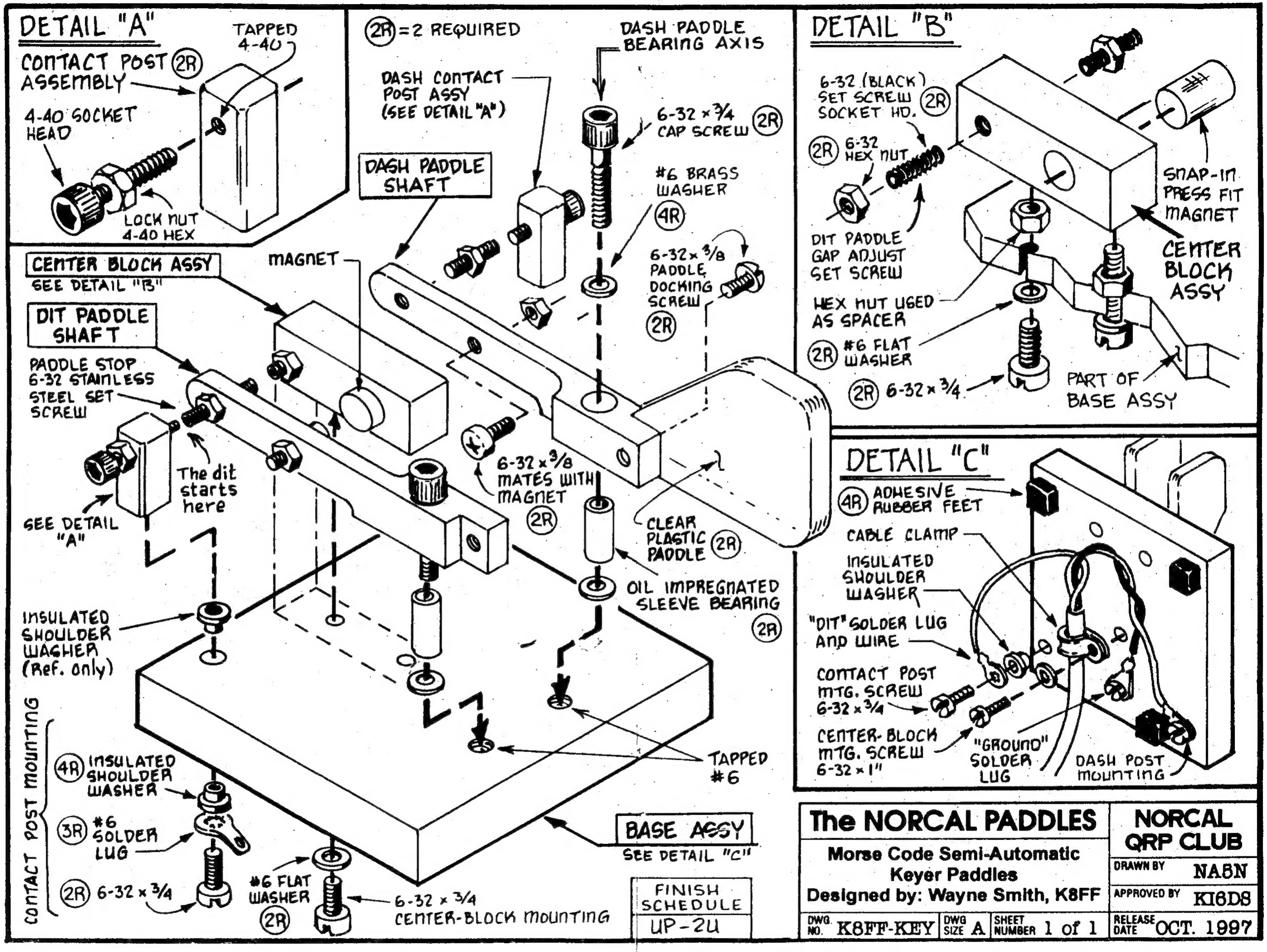
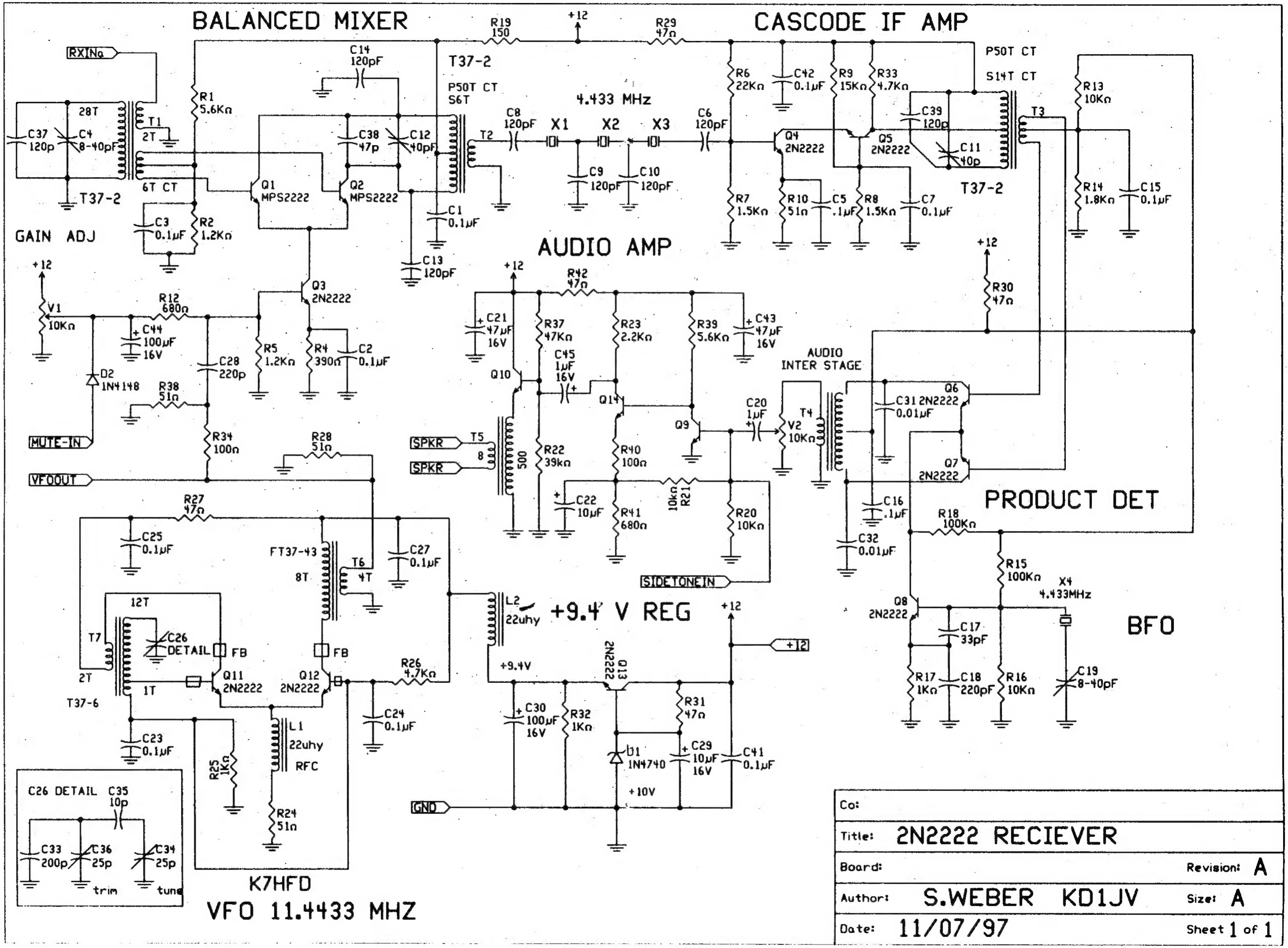
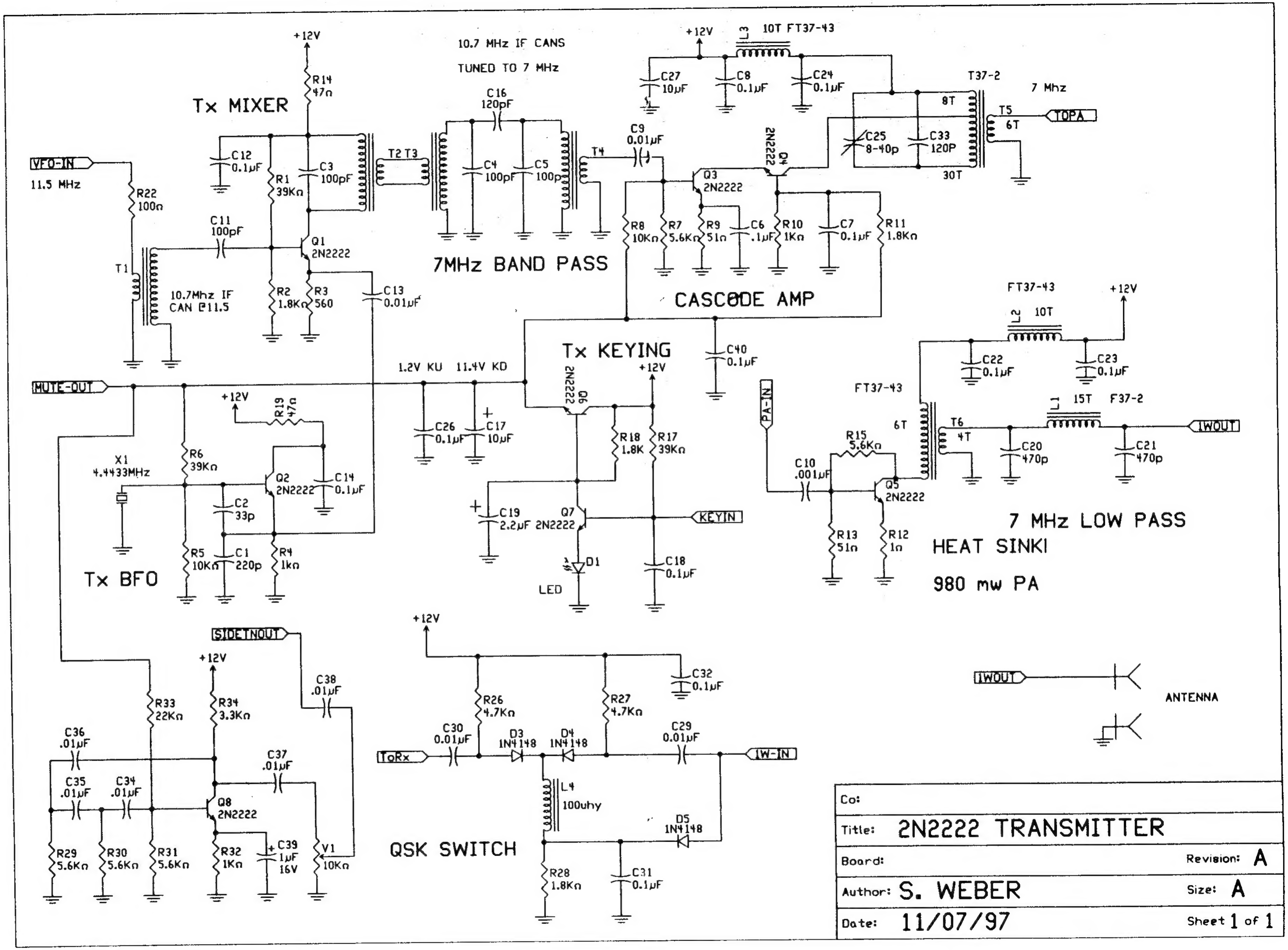

Base Assembly: 1 Required
Material: 1/2" Steel Plate
Contact Post Assembly: 2 Required
Material: Brass
Bushing: 2 Required
Material: Bronze
Paddle Handles: 2 Required
Material: Clear Acrylic, 3/16" Sheet
Dit an Dah Shafts: 1 of each required
Material: Brass
Center Magnet Assembly: 1 Required
Material: Brass
L. H.
R. H.
Holes:
A = .250 Thru
B = 6-32 Tapped Thru
C = .140 Thru
D = 4-40 Tapped Thru
E = Ream .2535 Thru
F = Tap 6-32, .250 Deep
G = Tap 6-32, .188 Deep
Tolerances:
.0 +/- .015
.00 +/- .010
.000 +/- .005
Frac. +/- .015
NorCal K8FF Paddles
Designed by Wayne Smith, K8FF
Drawing by KI6DS, Sheet 1 of 1
November 1997
KE6RIE, Machinist Consultant



DETAIL "A"
CONTACT POST (2R) ASSEMBLY
TAPPED 4-40
4-40 SOCKET HEAD
LOCK NUT 4-40 HEX
(2R) = 2 REQUIRED
DASH CONTACT POST ASSY (SEE DETAIL "A")
DASH PADDLE BEARING AXIS
6-32 × 3/4 CAP SCREW (2R)
DASH PADDLE SHAFT
#6 BRASS WASHER (4R)
6-32 × 3/8 PADDLE DOCKING SCREW (2R)
CENTER BLOCK ASSY
SEE DETAIL "B"
MAGNET
DIT PADDLE SHAFT
PADDLE STOP 6-32 STAINLESS STEEL SET SCREW
The dit starts here
SEE DETAIL "A"
6-32 × 3/8 MATES WITH MAGNET (2R)
CLEAR PLASTIC PADDLE (2R)
OIL IMPREGNATED SLEEVE BEARING (2R)
INSULATED SHOULDER WASHER (Ref. only)
TAPPED #6
CONTACT POST MOUNTING
(4R) INSULATED SHOULDER WASHER
(3R) #6 SOLDER LUG
(2R) 6-32 × 3/4
#6 FLAT WASHER (2R)
6-32 × 3/4 CENTER-BLOCK MOUNTING
BASE ASSY
SEE DETAIL "C"
FINISH SCHEDULE
UP-2U
DETAIL "B"
6-32 (BLACK) SET SCREW SOCKET HD. (2R)
(2R) 6-32 HEX NUT
DIT PADDLE GAP ADJUST SET SCREW
HEX NUT USED AS SPACER
(2R) #6 FLAT WASHER
(2R) 6-32 × 3/4
SNAP-IN PRESS FIT MAGNET
CENTER BLOCK ASSY
PART OF BASE ASSY
DETAIL "C"
(4R) ADHESIVE RUBBER FEET
CABLE CLAMP
INSULATED SHOULDER WASHER
"DIT" SOLDER LUG AND WIRE
CONTACT POST MTG. SCREW 6-32 × 3/4
CENTER-BLOCK MTG. SCREW 6-32 × 1"
"GROUND" SOLDER LUG
DASH POST MOUNTING
The NORCAL PADDLES
Morse Code Semi-Automatic Keyer Paddles
Designed by: Wayne Smith, K8FF
NORCAL QRP CLUB
DRAWN BY NA5N
APPROVED BY KI6D8
DWG. NO. K8FF-KEY
DWG SIZE A
SHEET NUMBER 1 of 1
RELEASE DATE OCT. 1997


BALANCED MIXER
CASCODE IF AMP
AUDIO AMP
AUDIO INTER STAGE
PRODUCT DET
BFO
+9.4 V REG
GAIN ADJ
K7HFD
VFO 11.4433 MHZ
C26 DETAIL
4.433 MHz
Co:
Title: 2N2222 RECIEVER
Board:
Revision: A
Author: S.WEBER KD1JV
Size: A
Date: 11/07/97
Sheet 1 of 1


Tx MIXER
10.7 MHz IF CANS
TUNED TO 7 MHz
7MHz BAND PASS
CASCODE AMP
Tx KEYING
Tx BFO
7 MHz LOW PASS
HEAT SINK!
980 mw PA
QSK SWITCH
ANTENNA
VFO-IN
11.5 MHz
MUTE-OUT
SIDETNOUT
TOPA
7 Mhz
PA-IN
IWOUT
KEYIN
ToRx
IW-IN
1.2V KU 11.4V KD
10.7Mhz IF CAN @11.5
X1 4.4433MHz
LED
Co:
Title: 2N2222 TRANSMITTER
Board:
Revision: A
Author: S. WEBER
Size: A
Date: 11/07/97
Sheet 1 of 1